THE ONLY MAGAZINE FOR THE COMMODORE 64

YOUR 64 & VIC 20

DEC/JAN

95p No. 5



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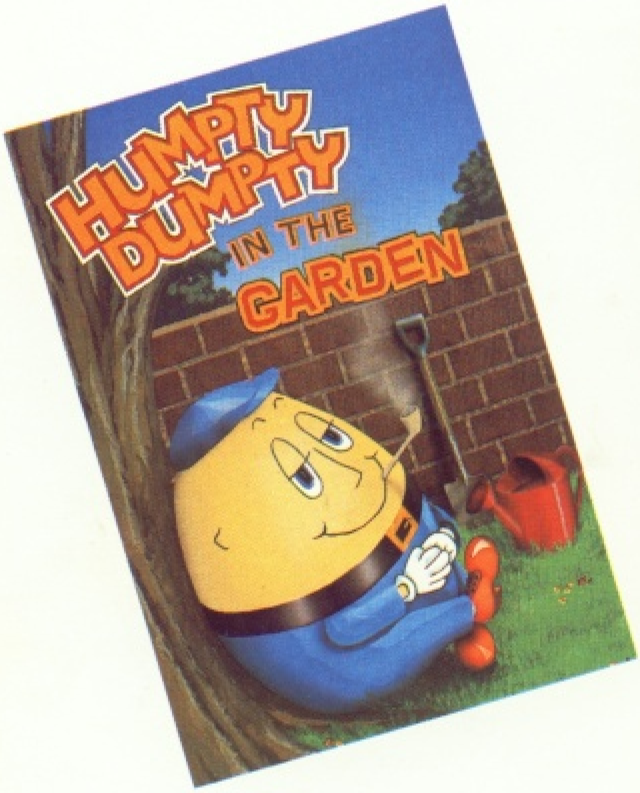
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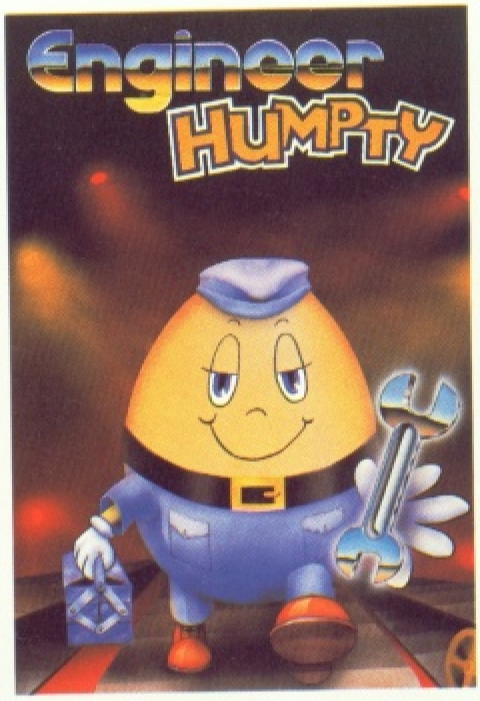
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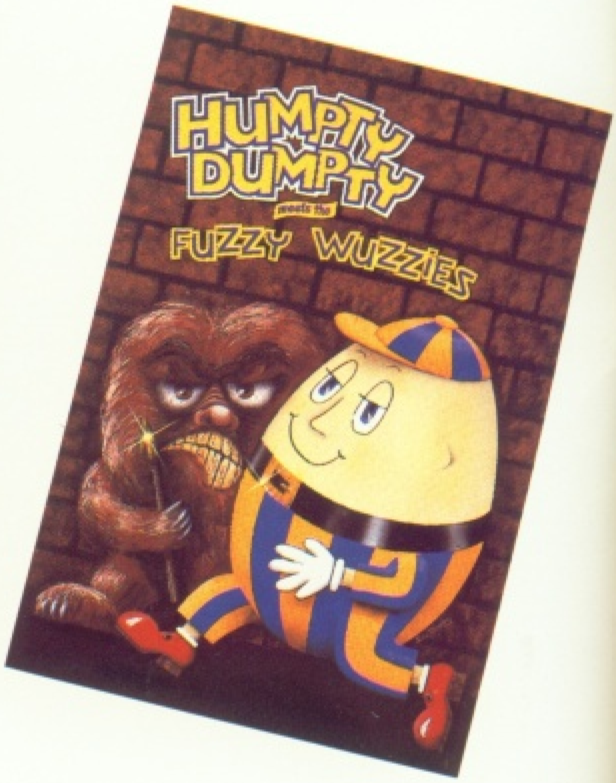
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THANKS
Y64 wishes to thank 'Commodore Business Machines (UK) Ltd; 'Tomorrow's World Today' (of Oxford Street); 'Pilot Software City' (of Rathbone Place); Osborne UK Ltd.

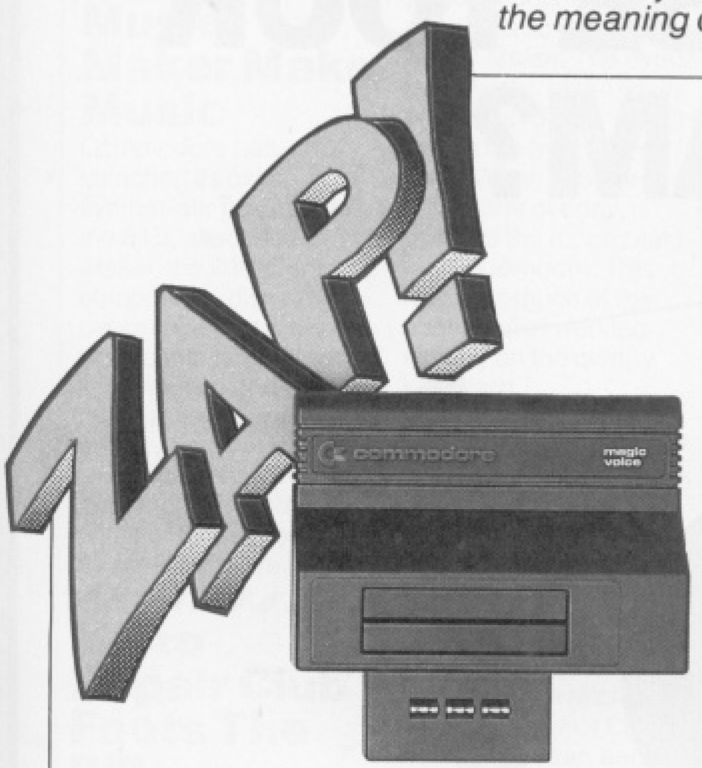
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Win a million, when to cry for help, the free repair shop, another synthesiser and the meaning of life.... want to know more? Read on!



Magic Voice is Commodore's own speech synthesiser for the 64. The phoneme-based cartridge allows other cartridges to be plugged into it, suggesting that Commodore intends to produce cartridge-based software with speech. Commodore didn't know either the price or launch date at the time of writing — in fact when we first got the cartridge Commodore was still denying that it existed — but I would expect it to cost around £50. Speak to Commodore on 0536-205252.

Commodore Takes Hart

Commodore seems to be cornering the market in tv artists. After persuading Rolf Harris to endorse its *Picture Builder* program (issue 4, page 5), the company has now talked Tony Hart into doing the same for *Art Master.*

While *Picture Builder* is intended as an aid to programmers, allowing you to design screen displays for use in games and so on, *Art Master* is primarily intended for designing pretty pictures for their own sake. Completed pictures can, however, be loaded into other programs.

According to Hart, "Art Master has so many features that it should challenge the imagination of any Artist." (I worry about people who spell art with a capital 'A'). These features include in-context help, where pressing the space-bar brings up a menu of commands available during the current operation, a magnified 'window' of the area you're working on, and a second screen — allowing you to try out radical alterations before doing it to the original picture.

Art Master is available on either cassette or disk priced at £11.99. Further details on 0536-205252.



Commodore Masquerades as Robert Maxwell?

It had to happen. We've had newspapers queuing up to give away a million pounds of their readers' money in bingo games, and software houses offering a cash prize of the first person to succeed in completing their games. Now Commodore has announced that it intends to give away a million pounds of its customers' money in a diamond treasure hunt.

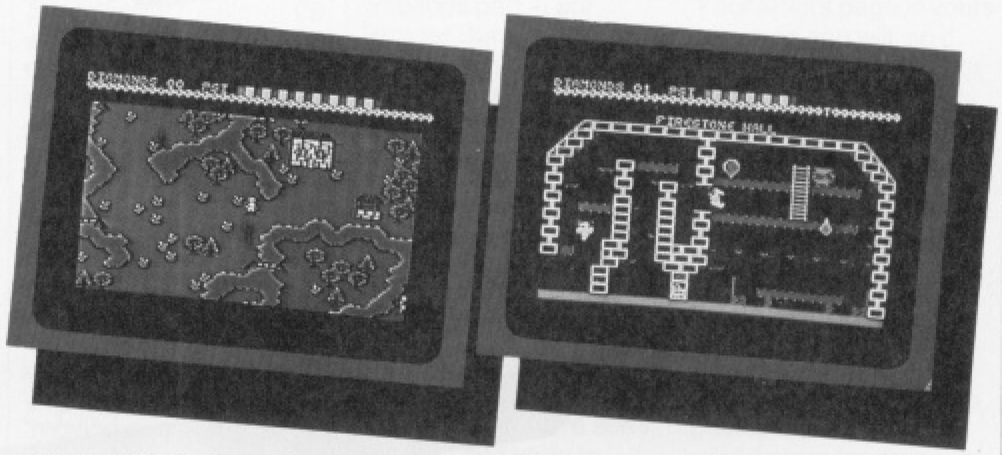
Spirit of the Stones is a book and software package based around a children's story by John Worsley. Set on the Isle of Wight, the book, *Stones* contains clues to the locations of 41 diamond talismans scattered around the island. The ultimate object is to find The Great Wight Eye — the largest of the talismans.

The software, an arcade game based around a 21-screen scrolling map of the Isle, contains additional clues to the riddles in the book. One refreshing aspect of the hunt is that you don't need to actually visit the Isle of Wight: if you think you know the location of a diamond, you can submit a postal claim to Commodore.

For every £15 package sold, Commodore is placing 50p into a trust fund. This fund will be closed either in December 1993 or when reach a million pounds. This would mean selling two million packages to an estimated 700 000 UK 64 owners — and foreign sales are not going to be that extensive since you need to be pretty fluent at reading English to solve riddles in the language!

Commodore's press release included one additional clue, and I don't see why you shouldn't have the benefit of it:

"A hidden lock reveals its ward
When keys be turned as fruit that's cored
Where two I miss upon a line
The letter's afterthought be mine
But heed indeed the joker's laugh
He may have lied or



published late last year, is very obviously based on *Masquerade* — the Kit Williams book that contained clues to the locations of a golden hare and had not a few readers rushing off to Bedfordshire with spade in hand! *Spirit of the* the fund reaches a million pounds, whichever is the sooner. The fund will then be divided equally among the finders of the talisman.

I'm sure Commodore will forgive me for saying that I don't for one minute believe that the fund will *blown the gaff*
And longer shall the riddle remain
Greater then the final gain

I just hope the content is better than the scansion. *Spirit of the Stones* is available on either tape or disk from Commodore stockists.

On-line help

Helpline is a free service exclusively for *Y64* readers! If you want help or advice on any aspect of computing 64 style, we now have a special phone number to call: the *Y64 Helpline.* You can ring us for technical help, product information, phone numbers of companies or whatever.

Helpline is open on Tuesday and Thursday afternoons between 2pm and 5pm. Please note these times carefully if you want to use the service: we don't have extra staff to handle these calls, so we have to restrict the times to allow ourselves time to deal with them and still produce the magazine!

Helpline should be open by the time you read this (British Telecom permitting!). The telephone number is 01-636 2416.

Ssoft Cushions Its Prices

Ssoft has cut the price of *Ssoftdata* and *Ssoftbank* (issue 2, page 11) to £5.95 each. Alternatively, *Y64* readers can buy both programs for £9.95 including P&P — just enclose this paragraph with your order. Ssoft is on 061-973 1079.

Commodore Makes Music Maker Make Music

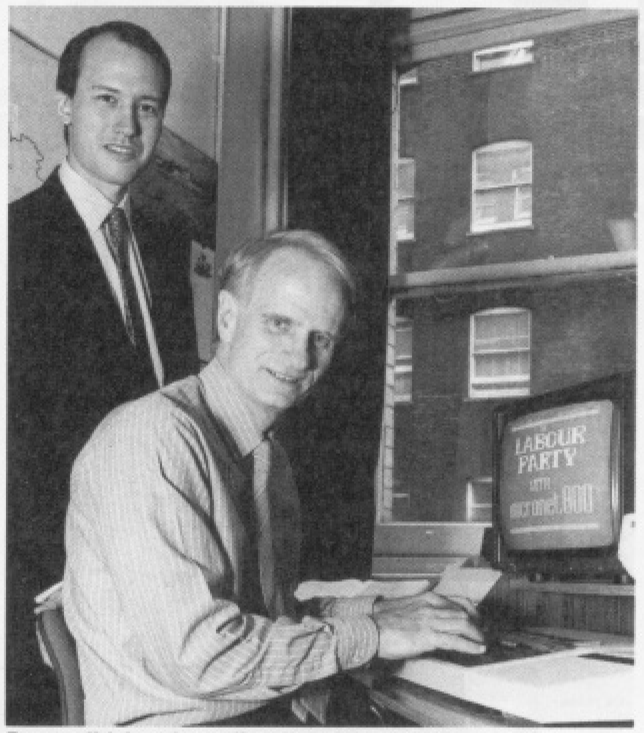
Commodore has launched its own synthesiser package for the 64. Called *Music Maker*, the £30 program comprises a disk or cassette, a music tutor book containing 28 well-known tunes and a musical keyboard overlay.

The package itself is less sophisticated than some of those produced by other software houses, for example *MusiCalc* (issue 4, *Open Access*, page 3), but the keyboard overlay is so far unique to *Music Maker*. The overlay is a 24-key, piano-style, plastic keyboard that sits on the top two rows of keys. When you press a key on the overlay, it presses the (computer) key underneath. This removes much of the confusion of working directly on the qwerty keyboard.

The overlay is not without its problems, however. I noticed one bug as soon as I started to use the package: to LOAD a file from disk you have to lift the keyboard overlay, press one or more numeric keys, put the overlay, back then press RETURN! The overlay I used was also extremely badly made, though Commodore assures me that this only applies to the pre-production units.

Music Maker should be available "shortly" from the usual Commodore outlets. Commodore is on 0536-205252.

Y64 will shortly be carrying out a full comparative review of all the music packages available on the 64.



Even politicians have discovered comms, though this particular one doesn't seem to have much taste in micros. Labour's Information Technology spokesman Jeremy Bray (he's the one pretending to type) is one of five MPs with Micronet 800 mailboxes. His companion is Micronet's managing director Timothy Schoonmaker.

Micro Repair Club Foots The Bill

You can picture the scene. Your CBM 64's guarantee runs out at midnight, and the machine promptly keels over and dies at ten o'clock the following morning.

If that sounds like that sort of thing your machine would take pleasure in doing, you might like to check out the Micro Repair Club. For £24.95 for the first year, and £14.95 for each subsequent year, the Club will cover your machine against breakdown. If it does break down, you send it to a repair company and the Micro Repair Club foots the bill.

The Club is on 01-946 7777.



MirrorSoft's latest software releases — from a "no-diet weight-control system" to a test for psychic powers. The five packages are part of Mirrorsoft's Home Discovery series, intended to be both practical and easy to use. The cassette versions retail at £9.95, and disks at £12.95. MirrorSoft is on 01-822 3947.

Do Androids Dream Of Electric Sprites?

The Android Dreams Software Company has announced a low-cost sprite editor to help games designers. *Expert Sprite Editor* retails for £8 and seems to include all the features you could wish for. Features include data compression, allowing up to 224 sprites to be edited; up to 8 sprites can be simultaneously edited; up to eight layers of sprites can be created; editing using either keyboard or joystick; mirroring; fast 'paging' of sprites; and "moving and stationary animation". *Stationary* animation? Android Dreams is on 021-458 4475.

Solar Has The Book Of Changes Taped

Does my partner love me? Are we compatible? Do we have a future together? What do I want most from life? Just in case you've been pondering these and other such questions of monumental importance then your luck is in for *The Love Oracle* is here! Published by Solar Publishing, the package comes with Blandford Press's book *The I Ching on Love* and all for a mere £20. Er, thanks, Solar. Don't call us, we'll call you (on 01-251 8119).

Thanks!

Many thanks to all of you who took part in our Reader Survey in Issue 3. Your comments, ideas and preferences are extremely useful to us, and should also ensure that you get the type of magazine you want.

A large number of you enclosed letters with your survey forms giving general comments about the magazine — something that was much appreciated. We're sorry that we can't reply to these personally — we'd have to cancel the next six or seven issues to make time! — but rest assured that all your comments have been noted, and thanks very much for taking the trouble to write.

One thing we've learnt from the survey if nothing else is that *Y64* readers aren't short of ideas! We've begun compiling a list of the most popular ones, and these will gradually be incorporated into future issues of the magazine.

A number of you wanted specific sections of the magazine for help with technical problems, hints on tackling adventure programs, 'hacking' programs, complaints about poor service from software houses and so on. We've just one word to say to the likes of you . . . *Missives!* Your letters page is yours to use as you will, so if you want help from us or other readers, write!

Finally, the winner! Choosing a winning suggestion wasn't easy given all the excellent ideas received, but we had to choose one. The winning suggestion was from *Niall Inglis of Kinneswood* who suggested a *Y64* bulletin board. A dial-up board would allow readers with modems to send us instant electronic mail, submit programs and download Keyboard Kapers listings. This is something that we will be looking into, so your wish may come true! In the meantime, don't forget that you can send electronic mail to us via The Blandford Bulletin Board at 300-baud on 0258-54494, and soon we'll be on Compunet too. Congratulations, Niall — the disk drive and software is on its way!

Sorry, Wrong Number

The phone number we gave for Tymac in issue 4 should have read 021-643 8899. Apologies to all concerned.

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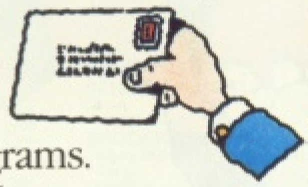
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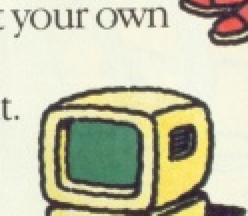
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2. Write letters and receive replies.



3. Work together on new programs.
4. Do homework with a friend.
5. Upload and store information and programs at realistic rates.
6. Download data to study later.



7. Stay up to date with new software releases
8. Buy the latest software, from leading companies, at knockdown prices.
9. Ask for advice on programming.
10. Get your programs de-bugged.
11. Find hints and tips on microcomputing.
12. Read all the latest microcomputing news in Compucat.
13. Keep in touch with new peripherals.
14. Find out who's giving the best deals.
15. Download programs directly into your Commodore 64.
16. Save them straight onto disk or cassette.
17. Vote on how good you've found new programs to be.
18. So you'll have a good idea of which programs are the best.
19. Learn how to compose and edit your own pages of information.
20. Advertise unwanted equipment.



21. Swap equipment.
22. Sell your own programs.
23. Also share your programs with other Modem owners.
24. Receive information to help you in your work.
25. Pass on information to other people in your line of business.
26. Download viewdata software.
27. Exchange data files with other 64 Modem owners.
28. Build a school software library.



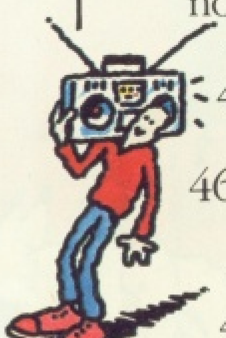
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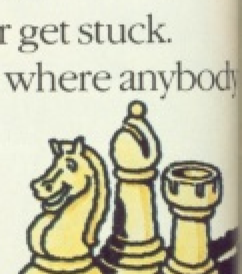
32. And arithmetic for the under-12s.
33. Plus English for all grades.
34. Take a home typing course.
35. And there's up to ten new education packages every month.
36. Start a special interest club amongst like-minded Modem owners.
37. Join a Commodore User Club.
38. Seek advice from Commodore's information service.
39. Talk directly to Compunet, make suggestions or even criticise.
40. Look through the bargains available through teleshopping services.



41. Make great savings on fridges, cookers and dishwashers.
42. Snap up a bargain camera, tripod or flashgun.
43. Advertise cars, household goods or anything you have to sell on notice boards.

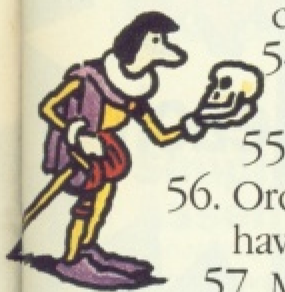


44. Sound out Hi-Fi prices.
45. Print mainframe information on your own printer.
46. Organise conventions with other Compunet subscribers.
47. Compunet's easy to use.
48. Select HELP if you ever get stuck.
49. Explore Compunet's jungle where anybody can display anything.
50. Play games, like chess.



51. All this is available now. Let's see what you could look forward to in the future.
52. Look up travel timetables, for land, sea and air

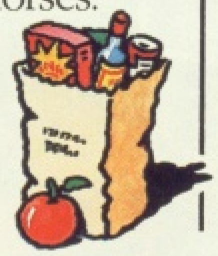
53. Find out what's showing at your local cinema.



54. Book seats for a night at the theatre, opera or ballet.

55. Have a flutter on the horses.

56. Order your groceries and have them delivered.



57. Make a computer date in complete privacy.

58. Put your finger on a video.

s will welcome Compunet different reasons.

59. Look into what's new in photography.

60. Request an insurance quotation.



61. Check out your bank account.

62. Ask for a bank loan.

63. Choose a restaurant.

64. Discover a new diet plan.

65. Rustle up a recipe.

66. Book a holiday with a major tour operator.

67. Reserve rooms in hotels all over the world.

68. Put your finger on a jeweller.

69. Plan an extension, fitted kitchen, or remodel your bathroom.



70. Seek advice on sowing seasons from expert gardeners.

71. Unearth a garden centre.

72. Dig up a builder, or builders merchant.

73. View a new home.

74. Arrange your mortgage.

75. Hire a car, for business or pleasure.

76. Ask for DIY advice from a professional.

77. Ferret out plant hire companies.

78. Get a quote for double glazing.

79. Find a squash court, keep fit class or gymnasium.

80. Restock your wine cellar, with reputable vintages or promising nouveaus.

81. Send flowers, chocolates and even champagne.



82. Deposit money with a building society.

83. Become a member of a bookclub and enjoy generous discounts.

84. Discover who your favourite soccer team is playing.



85. Track down sporting events.

86. Make a shrewd investment with the help of a stockbroker.

87. Link up with a legal eagle.

88. Find a new job, or advertise a vacancy.

89. Look up currency exchange rates.

90. Shop around for the best store prices in town.

91. Enter big exciting competitions to win massive prizes.

92. See what a recognised astrologer reads into your future.

93. Take part in multi-user adventures.

94. Uncover fresh customers to expand your business.

95. Find a new flat to rent in the area of your choice.

96. Place an order for a new outfit from a mail order catalogue.

97. Search for a new car, tractor, trailer or van.

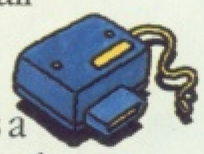


98. Trace a mechanic.

99. Book a berth on a cruise or charter a plane.

100. And who knows, someday you may be able to book your blast off in a shuttle.

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MISSIVES

Y64 welcomes correspondence on any and all aspects of computing a la 64. Funnies, straights, anguished pleas for help. 14 Rathbone Place, London W1P 1DE.

Simply Assemble

I thought Andrew Bennett's comparative review of assemblers was interesting and generally fair, except in two points. First, it did no service to your readers when it said that 'Simply Assemble' "...demands a considerable degree of disk or cassette access . . .", as if this is a great disadvantage with no benefits. By assembling from disk or tape, it is not limited by having to hold both files in memory, with the need for expert knowledge to shuffle everything about in the machine when the assembler will otherwise get in the way. It is possible, for instance, to assemble programs for a totally different 6502 or 6510 machine, including one like the 8096 that has more memory than the 64. Even the loader is 'intelligent', shifting itself out of the way if necessary. It is also possible to combine a series of 'off-the-shelf' subroutines from disk or tapes, without re-typing them, or to assemble the same program with different sets of memory map addresses held as standard in separate files. Disassembled files can also be held on disk or tape for later modification.

Secondly, 'Simply Assemble' is described as ". . . not recommended for the beginner, but worth a look by the more experienced", in spite of the fact that our tests show it to be more easily used by a genuine beginner than any other assembler package we know. For example, to type in assembly language from a magazine listing merely requires the user to type, press the (optional) tab key if a new column is required, and press RETURN at the end of each line. Inserting new lines is a matter of opening up a space and typing them in where they can be seen to go, without line numbers or obscure line editor instructions. This assembly language editor is based on experience with our 'Simply Write' word processor, which is so simple to use that it is even in many primary schools. The helpful manual does not start by assuming familiarity with monitors, memory maps and jargon, like so many of the assemblers I have attempted to use and given up.

Our 'Simply Assemble' approach to writing assembly language and assembling it is quite different from any other package we know, and we feel it deserves to be looked at from an unbiased point of view, not from the viewpoint of an expert long used to more traditional methods. Of course, if you already know your way around, then even the simplest map is likely to seem more complicated than following familiar signposts, however misleading they may be to the newcomer.

Brian Tregar
Simple Software Ltd, Brighton

The Joystick Jam Jinx

With reference to the article in the October issue, Joystick Jam by Rob Christer, I have just finished typing the listing in and on running it I only get the first page of instructions and then the computer locks up. The page one instructions remain on screen and the computer will not accept any further commands. I have checked my typing for any errors but cannot find any. I have also thoroughly checked the DATA statements for errors, again none. The program seems to run until it meets a SYS command and then it locks up. I've run some of the other sections of the program, with the same result.

I would appreciate any help you could give as this program is just what I have been looking for. If there are any corrections to the listing I would be grateful if you could let me know.

R F Richardson
Harlow, Essex.

I believe the main reason that some readers have had difficulty with Music Assembler is an out of memory error. The following changes will correct this.

Firstly, may I point out that the Interrupt Program and the Main Listing are two separate programs, and should not be loaded into memory at the same time.

The Interrupt Program is a machine code loader which allows music already written by Music Assembler to be used in your own program.

Secondly, the problem may be caused because Music Assembler is written very tightly, that is, no unnecessary spaces between keywords, etc.), and the top of memory in the original program was lowered to give as much memory as possible to the music file. If you've added spaces when typing it in, the program will probably run out of memory.

The best advice I can give is to remove all unnecessary spaces and REM lines from the program. If this doesn't rectify the problem then the following changes will lift the top of memory and free an extra 512 bytes.

1. Change the POKE 56,79 to POKE 56,81 in line 1000.
2. Add the following line: 1001 POKE 51,240: POKE 52,81
3. In line 4520 change: MW=20480: to :MW=20992:

If the above changes are made then the following changes will have to be made to the Interrupt Program:

1. Change the 80 in line 160 to 82
2. Change the 80 in line 250 to 82
3. Change the 73 in line 60 to 81
4. Change all 79's in lines 50 to 140 to 81

The only other advice I can give is to check the program carefully for typing errors, making sure you haven't typed a number one instead of a letter l, etc.

Rob Christer.

Just Perfect

I am writing to you in connection with the "New Resolutions" article in issue 2.

The 'perfect fill' was too slow so I devised a faster way of doing it using the extended Basic in issue 1:

```
9 R=99: X0=160: Y0=100
10 X1=R: Y1=0: E=1/R: FOR T=0 TO
1* *R
12 X1=X1+E*Y1: Y1=Y1-E*X1
14 X%=X1+X0: Y%=Y1+Y0: @PLOT:
X%=X0+X1 Y%=Y0-Y1: @LINE:
NEXT T
```

This routine fills a circle of radius 99 in 27 seconds.

Mark Beveridge
Kincorth, Aberdeen

False Economy

Scarcely a month goes by without someone rediscovering that if you cut a second write notch in a floppy case, you can turn it over and use it. (*Missives*, issue 3). Most editors point out that single sided disks have failed the production test on one side and therefore there is a risk.

But there is really a far more serious danger than this.

If you turn a disk over in a single sided disk unit it gets rotated in the opposite direction inside its cover. This means that while you are using the 'flip' side, dust and debris which has been carefully swept up and retained by the fibres on the inside of the case, are now not only shaken out on to the 'A' side again, but because of the 'lay' of the fibre pile, are actually in a situation where they may be forced into the sensitive surface. You may get away with it, but you run the chance of wrecking the first side.

Double sided disks are only rotated in one direction and have read/write heads on both sides.

Reginald A. Mascall
Thornbury, Bristol

Chesst an Idea

While the 'Colossus 2.0' Chess program seems very good, it does have a tendency to crash now and then. This happened to me once when I pressed the space bar in 'replay' mode, and another time the program ceased to respond to the keyboard for no apparent reason. To those of your readers who have not themselves found a method of re-running the program without loading from tape again, I would like to suggest the following:

1. Reset the computer (by using a button as previously described, or by grounding a 'reset' sin);
2. Type SYS 24064 <RETURN>.

The program will now run, although of course the positions are re-initialised.

Peter Stephenson
Jesmond, Newcastle-upon-Tyne.

DIY Turboload

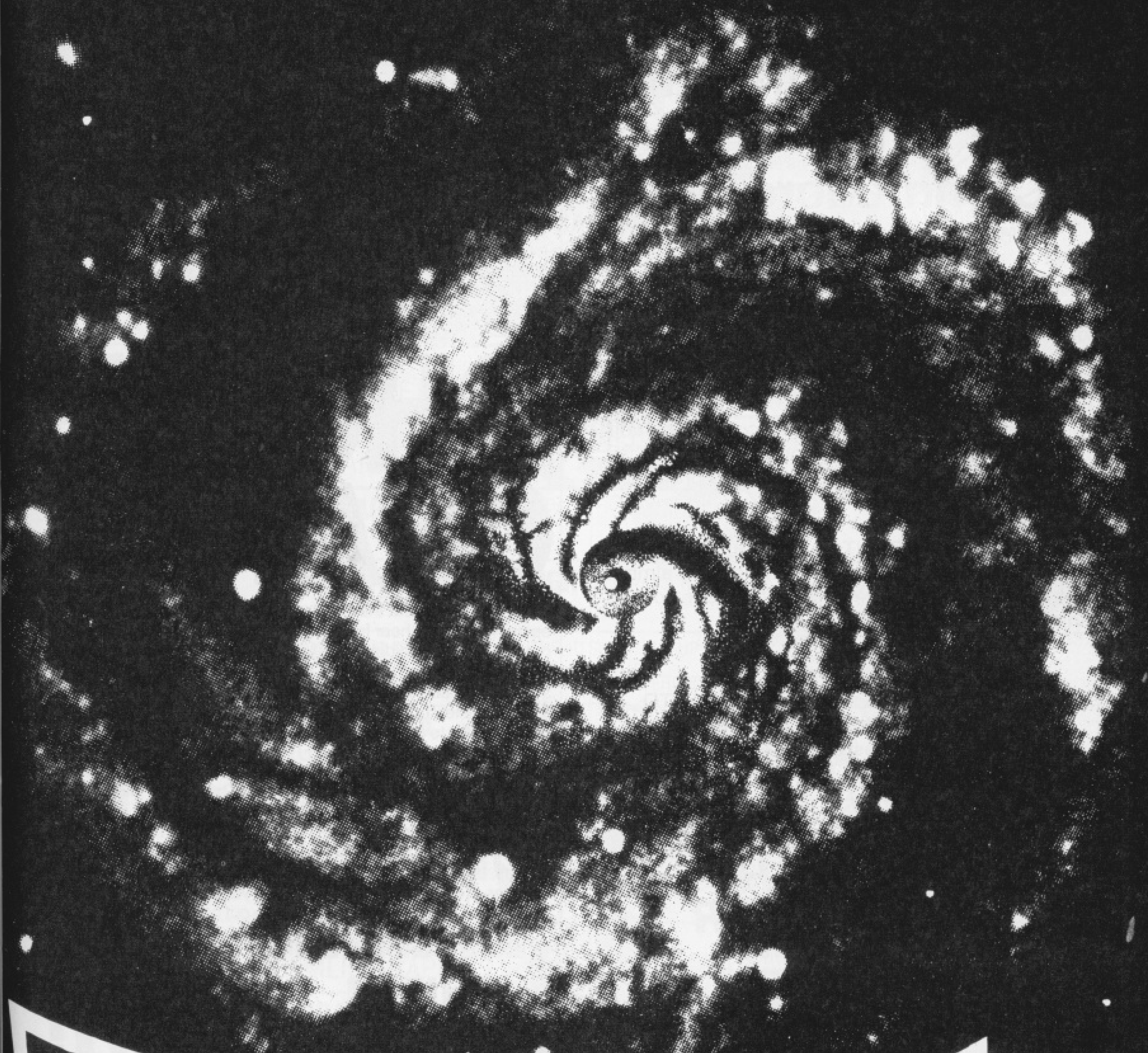
Having just bought a 64, I have heard of a program that loads normal programs at a faster rate (commonly known as "Turboload").

I know that it is probably a pretty long program (and in machine code — which I am now fluent in!) but do you think you could possibly give me a brief outline of the program (or alternatively publish an article in one of your near future issues)? I would be very grateful if you would help me.

M Danzig
Watford, Herts.

Turboload is a system used by software houses for commercial programs. If you'd like to speed up your own programs, try a utility called Hypersave-64. Details of this are in issue 2, page 8, or you can ring Dosoft on 0253-593288. Ed.

THE GREAT SPACE



RACE

MOVI SOFT 2

YOUR OWN CHOICE CHARTS

Thanks to all you out there who sent in your considered opinions, hope to hear from you again soon; and if there are one or two of you who didn't — well, you know us, never leave a space where a coupon will do, so why not take advantage and start a new habit today? You'll have noticed by now that we've made it easier for you by not insisting on your comments, but if you still want to elucidate feel free — we'll still print the enlightening ones.

The sender of the Chosen Coupon will be sent a parcel of surprise software (and it could be you)! The winner this month is Ian Smith of Aveley in Essex, hope you're enjoying it, Ian.

This month's top ten is a bit reminiscent of last month's top ten, it's only after the half-way mark that we see any new names. We confidently expect Zaxxon to attain the upper reaches of the table next month, after you've all read our mega-review, but of course it's up to you, so cut out that coupon!

YOUR 64 CHOICE TWENTY

My top five games for the **Commodore 64** are:

1 ____________

2 ____________

3 ____________

4 ____________

5 ____________

Name____________

Address____________

All polling slips should be mailed to: **Your 64 Choice Twenty, 14 Rathbone Place, London W1P 1DE.** (By all means send a photocopy if you'd prefer not to harm the issue.)

YOUR 64'S TOP TWENTY

THIS MONTH	LAST MONTH	TITLE / PUBLISHER	COMMENT
1	2	**INTERNATIONAL FOOTBALL** COMMODORE	THE 3D FOOTBALL SEASON KICKS OFF WITH A WINNER.
2	7	**REVENGE OF THE MUTANT CAMELS** LLAMASOFT	A VENGEFUL COMEBACK BY THE CAMELS OF MUTANIA
3	1	**BEACH-HEAD** ACCESS	A SLIGHT KNOCK BUT STILL A FAVOURITE
4	11	**THE HOBBIT** MELBOURNE HOUSE	CAN BILBO HOLD THIS POSITION FOR A MONTH?
5	5	**MANIC MINER** SOFTWAREPROJECTS	Q: HOW DO YOU KNOW WILLY'S SECOND NAME ISN'T ARTHUR?
6	4	**HUNCHBACK** OCEAN	CAN ESMERELDA NEED THIS MUCH RESCUING?
7	8	**TALES OF THE ARABIAN NIGHTS** INTERCEPTOR	WHAT'S THE ARABIC FOR "HOARSE"?
8	6	**FORBIDDEN FOREST** AUDIOGENIC	THE 4D SHOOT-EM-UP WITH A DIFFERENCE
9	NEW	**FALCON PATROL** VIRGIN GAMES	SECOND ONLY TO FALCON PATROL 2 AND ABOUT 8 OTHERS.
10	10	**DECATHLON** ACTIVISION	APPROPRIATE NUMBER FOR A DECATHLON EH?
11	NEW	**FOOTBALL MANAGER** ADDICTIVE GAMES	THIS FOOTBALL MANAGER IS THE BOSS
12	NEW	**WANTED MONTY MOLE** GREMLIN GRAPHICS	NOT JUST ANOTHER SPY STORY
13	RE-ENTRY	**HOVER BOVVER** LLAMASOFT	I NEVER KNEW MOWING THE LAWN COULD BE SO EVENTFUL
14	3	**VALHALLA** LEGEND	THE LEGENDARY VALHALLA SUCCUMBS TO THINGS MORE MODERN
15	NEW	**ZORK I** INFOCOM/COMMODORE	YOU TOOK YOUR TIME BUT ZORK GOT THERE IN THE END
16	NEW	**ZAXXON** US GOLD	SIXTEEN GOING ON ONE?
17	NEW	**THE BOSS** PEAKSOFT	HE MIGHT BE THE BOSS BUT HE'S NO FOOTBALL MANAGER
18	9	**BOOGA-BOO** QUICKSILVA	YOU ARE THE FLEA BUT IT (P)AIN'T YOUR DRAGON (OH NO!)
19	14	**DALEY THOMPSON'S DECATHLON** OCEAN	NOT SUCH AN APPROPRIATE NUMBER FOR A DECATHLON EH DALEY?
20	NEW	**BLAGGER** ALLIGATA SOFTWARE	BLAGGER SENIOR USURPS HIS SON.

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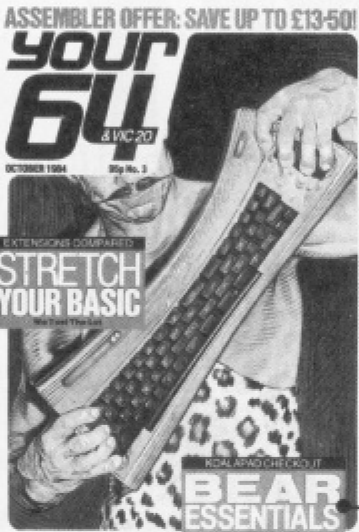
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your 64

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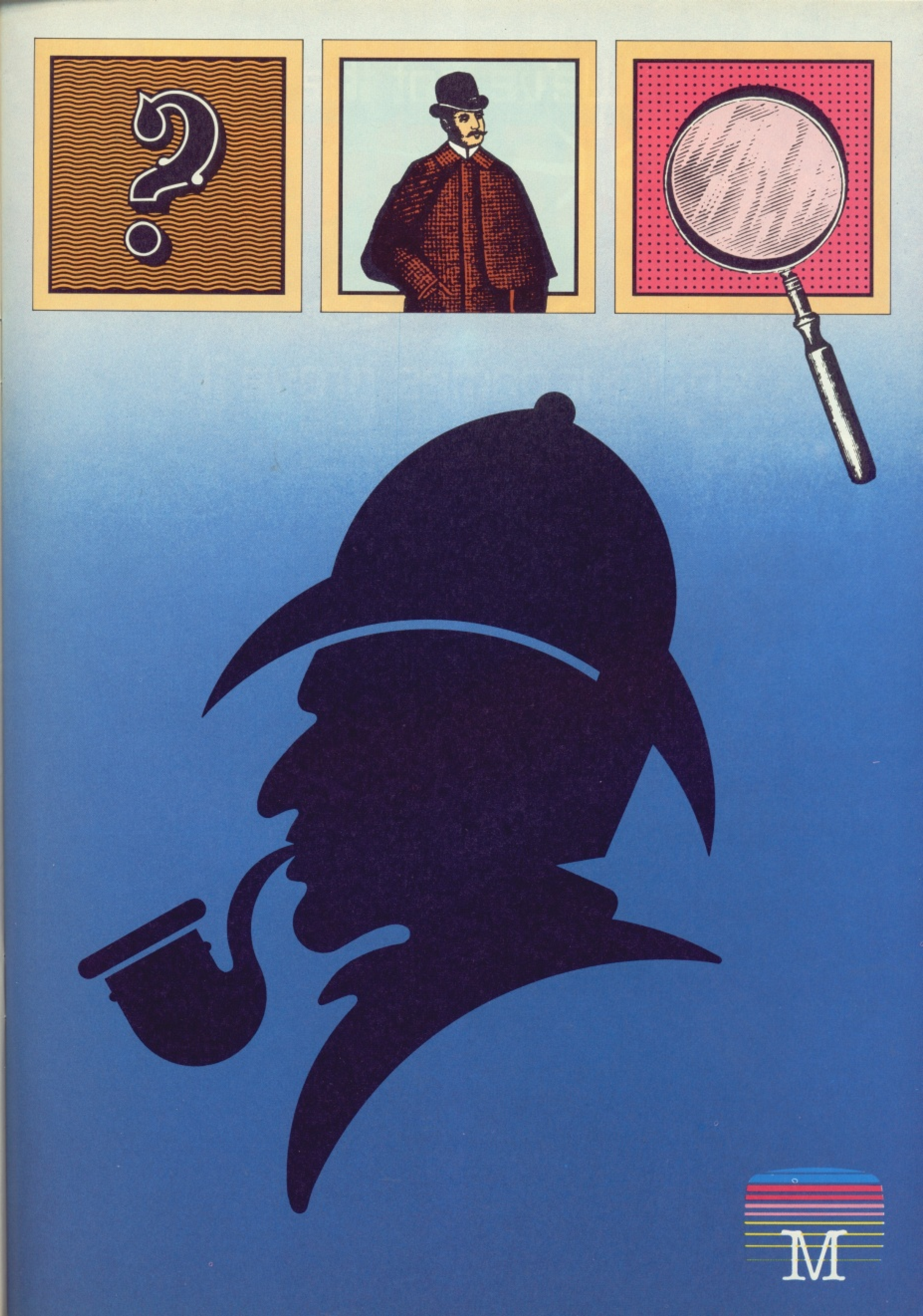
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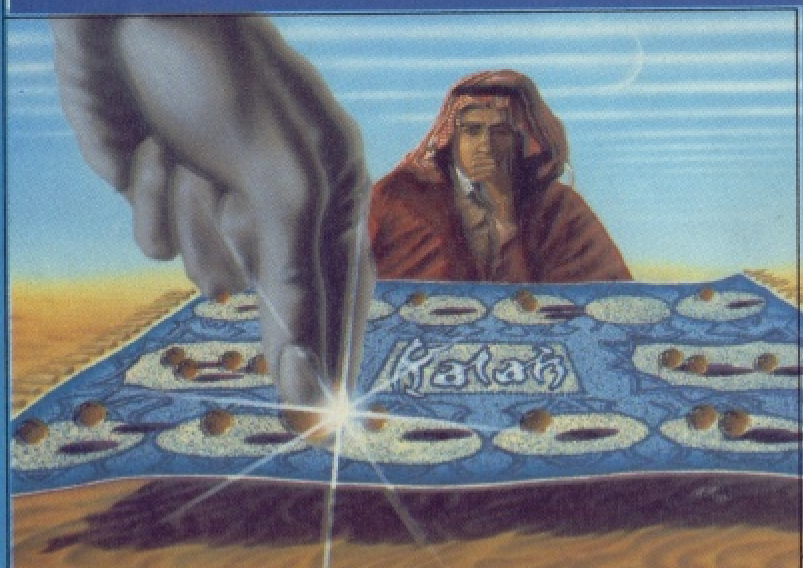
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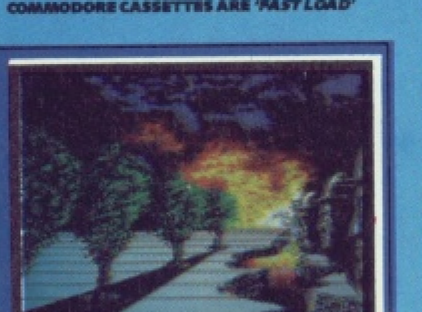
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MODELLING MINDS

Harvey Mellar explains how artificial intelligence is affecting the way we view the process of education, and how education is influencing the development of artificial intelligence languages.

The science of Artificial Intelligence is about trying to get machines to act in intelligent ways. You could say that education is about trying to get children to act in intelligent ways, so there should be some connection between the two! Certainly, AI has pioneered a new way of looking at intelligence that is having a significant effect on the way we view the process of education, and has already had a strong influence on the choice of computer languages used in schools.

AI is based on the idea that it is not enough to have a vague theory of how some mental process works. If you are really going to test your theory you have to put it in the form of a computer program that can be run. So early AI workers set about building computer models of how they thought the mind worked. They tried to write programs to solve problems, speak English, or prove theorems.

But they found that the computer languages available to them were unsuitable for writing these sorts of programs. So one of the first tasks was to devise more suitable languages. Lisp was the most important of these, but Prolog is nowadays grabbing more and more of the limelight since the Japanese gave it prominence in their Fifth Generation Project.

Logo

The Logo group at MIT were one of the first to bring AI ideas to bear on education. They devised Logo as a simplified form of Lisp — it was designed to be much more powerful than Basic, and yet easier to use. The teaching of mathematics was one of the areas of early interest, and turtle graphics was added to Logo for this purpose. The aim was always more to show children how to explore mathematical concepts, to learn to be mathematicians, rather than to teach them specific facts or techniques.

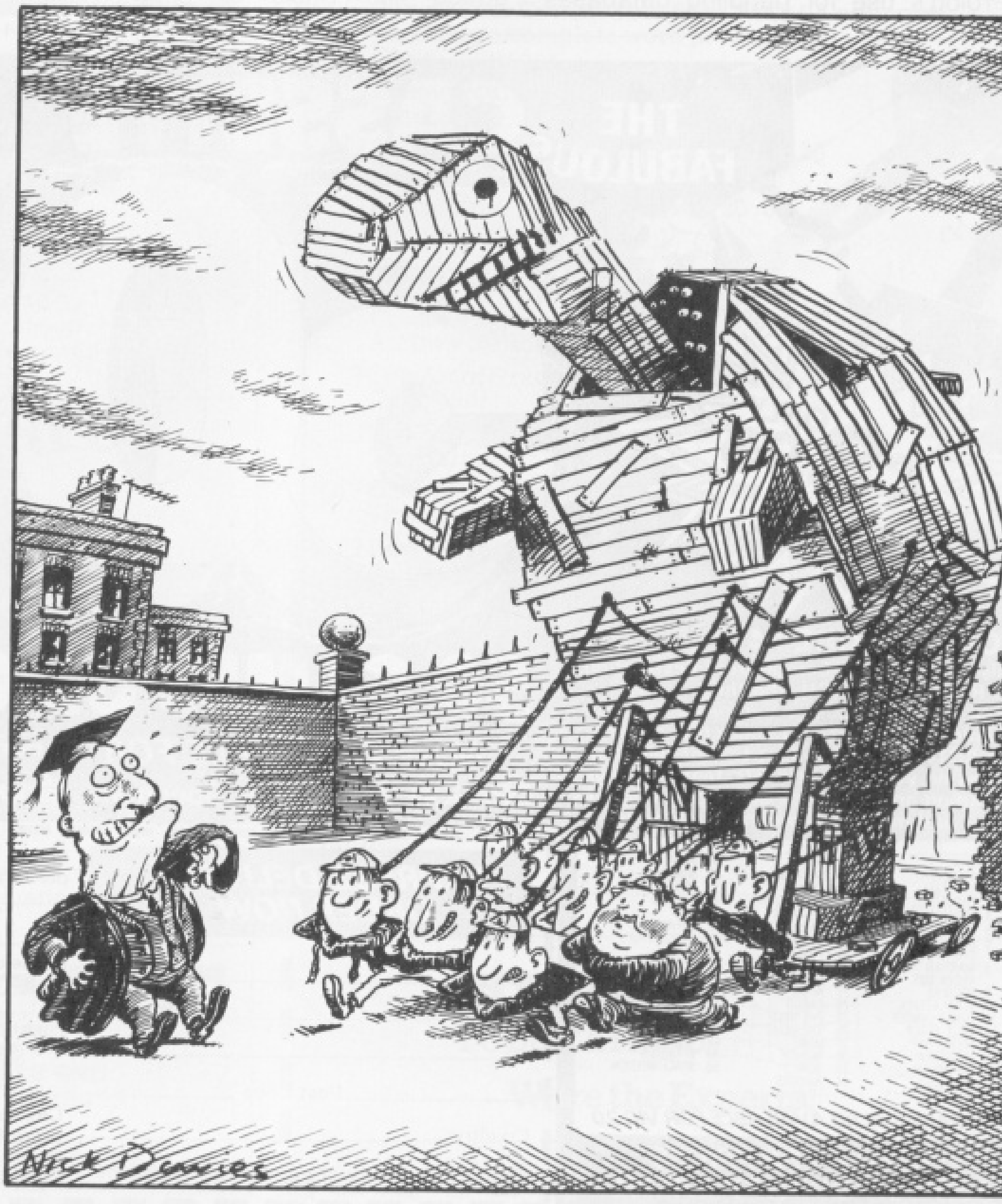
The more general goals of the Logo group included introducing children to the very ideas that were being used in AI to talk about mental processes. Children should begin to be aware of the mind as a computer. Children should be able to make 'model minds' using Logo, just as they make model trains using Lego.

Seymour Papert was the leading light of the MIT group. Papert was much influenced by the educational psychologist Jean Piaget, with whom he had taught for a number of years in Geneva. Papert attempted a synthesis of Piaget's ideas of child-centred, self-motivated learning with AI, and came out with a revolutionary educational position.

He called for children to be given massive access to computers supporting Logo-type learning environments. Learning was to be opened up, children were to explore their own Logo projects, supported by a growing 'computer culture', that would undercut the authoritarian teacher-pupil relationship.

It is unclear which came first for Papert, the liberal child-centred educational philosophy, or Logo. It might not be too unkind to suggest that Logo was something of a Trojan horse used to infiltrate radical educational ideas into the mainstream school system. If so, it has been at least as successful as its wooden predecessor!

Papert's ideas, and in particular his book 'Mindstorms', were greeted with tremendous enthusiasm in the educational world. Meanwhile, a much more staid movement was underway in Edinburgh. There, Logo was being introduced into schools, fully integrated with the mathematics curriculum. Detailed worksheets were used to teach Logo, and to explore specific mathematical concepts using Logo programs. The Edinburgh group put a great deal of emphasis on model build-



NICK DAVIES

ing in mathematics, but less on building models of minds, and much more at working within the school system.

The difference between the two groups is partly one of philosophy — Edinburgh wanted to *teach* mathematics *using* Logo, where Papert wanted Logo to be *made available* to children in order that they might learn through their own (gently guided) explorations. Here is an issue that is faced by every teacher. Logo has merely brought the problem to the fore.

Prolog

Prolog is so named because it is intended to allow PROgramming in LOGic. In theory, you simply add facts and rules to the computer's database and then query that database for the results you require. The user is no longer concerned with the details of how the computer solves the problem, but only the logical description of the problem. The language is said to be 'declarative' rather than 'procedural', since the user simply 'declares' facts and relationships, and leaves the computer to worry about the actual procedures involved in relating one to the other.

A group based at Imperial College has been using Prolog as a means of teaching logic to school-children. Their use of Prolog involves setting up simple databases in subject areas of interest to the children, and then interrogating them using Prolog.

Prolog's use for handling databases has been taken somewhat further by a group in Exeter. They've set up a database around a historical situaticn — the finding of a dead body in a bog in Jutland in 1952. The students can interrogate the database, either individually or as a class, and must eventually come to some sort of conclusion about how the body came to be there. The aim is to give the students a feel for the historian's task in sifting and assessing evidence, and — most importantly — asking the right questions.

> *"With Prolog, the user is no longer concerned with the details of how the computer solves a problem"*

You'll be pleased to know that even the Prolog supporters are split into two camps! The approach to Prolog I've described so far is the declarative approach. But every command in Prolog has a procedural interpretation as well, that is, it is possible to use Prolog in order to describe the *processes* involved in solving a logical problem (which is what we are doing when we program in a language like Basic or Logo). Some educationalists believe that the procedural interpretation should be taught alongside the declarative.

A piece of research using this dual procedural and declarative approach is one that offers a 'grammar kit' to students. Students can define grammars and watch them either generate or analyse sentences. They can thus build a simple natural language interface to their programs — a much more exciting task than those given to beginning Basic programmers (see issue 4).

The Logo/Prolog Debate

A good version of Logo is available for the 64, and plans are afoot for a version of micro-Prolog. Could we use both in schools or is there a conflict between them?

To some extent I'm afraid there is a conflict, if only because it's unrealistic to expect school children to have to come to terms with several computer languages. The two languages are suited to rather different areas, however, and so can live side by side. How far you can go in using both will depend on circumstances. Logo may well be of most interest to junior schools, as well as older mathematicians, and computer scientists, while Prolog has particular strengths for the humanists.

Our best hope may lie in the future, with the possibility of new languages combining *both* approaches.

FLAGS & COMPARISONS

THE COMPLETE Y64
MACHINE CODE TUTOR

Part 4: Flags & comparisons

- Indexed addressing
- Flags
- Greater-than and less-than comparisons

By now, your assembler should be starting to feel like an old friend. This month we venture further into machine code with an introduction to indexed addressing and flags. Let's start by dealing with last month's homework; it's this sort of exercise that you'll get most benefit from — the best way to learn anything is to practise it.

Homework Solution

The problem was to write a program to put the word HELLO at the top left hand corner of the screen with each letter in a different colour. Our solution is shown in the HOMEWORK SOLUTION box, but there are other ways to approach the task. Our listing is simply the best way we know to do it using the instructions you know already. If your program is different but works, that's fine: machine code is very much an "if it works, don't knock it" language!

The program is pretty easy to follow, but let's just run through it quickly. The screen code for each letter is loaded into the accumulator and stored in the appropriate part of screen RAM. Next a different colour code for each letter is loaded into the corresponding position in colour RAM. Finally the routine we supplied last month waits for a keypress before exiting to Basic.

Indexed Addressing

Last month we introduced the X and Y indices as if they were an alternative to the accumulator. In fact, they are designed to work with the accumulator to form loops. Have a look at the BASIC SPACE PROGRAM. This POKEs the value of B — 32, the ascii code of space (" ") — into the first 200 addresses of screen RAM. Thus the first 200 characters (five lines) on the screen will be replaced by spaces. Before we can write an equivalent program in machine code we need to look at a new instruction: INX.

HOMEWORK SOLUTION

```
          *=$C000            !Program start at $C000

          SCREEN = $0400     !Define label SCREEN
          COLSCREEN = $D800  !Define label COLSCREEN

          LDA #$08           !H
          STA SCREEN         !Start of screen
          LDA #$05           !E
          STA SCREEN+1
          LDA #$0C           !L
          STA SCREEN+2
          STA SCREEN+3       !Accumulator is still = #$0C
          LDA #$0F           !O
          STA SCREEN+4
          LDA #$01           !White
          STA COLSCREEN      !Start of colour screen
          LDA #$05           !Green
          STA COLSCREEN+1
          LDA #$07           !Yellow
          STA COLSCREEN+2
          LDA #$08           !Orange
          STA COLSCREEN+3
          LDA #$0E           !Normal light blue
          STA COLSCREEN+4
PRESSKEY  LDA $C7            !Location for what key is being pressed
          CMP #$40           !Normal value - if no key pressed
          BEQ PRESSKEY       !If no key then branch to PRESSKEY
          RTS                !Return to Basic
```

A possible solution to the homework set last month. The program places itself at memory location $C000, defines SCREEN as the start of screen RAM and COLSCREEN as the start of colour RAM. It then places the letters H,E,L,L,O into the first five bytes of screen RAM. Next it places five different colours into the first five bytes of colour RAM. Finally it uses the keypress routine we introduced last month to wait for the user to press a key before exiting to Basic.

INX, INcrease the X index, adds one to the current value of the X index. When the value of the index reaches $FF (decimal 255), it 'rolls over' to zero. INY, INcrease the Y index, of course has the same effect on the Y index. There is no equivalent for the accumulator, but this isn't necessary as we shall see later.

In our HOMEWORK SOLUTION program, we used a separate LDA and STA instruction for each letter and colour. This, of course, is both inefficient and time-consuming. What we really need is an equivalent of the POKE statement in line 120 of the BASIC SPACE PROGRAM. Here we are simply adding 1 to the top of screen RAM until the counter reaches 200, telling us that we've filled 200 locations. Fortunately there is a method of doing this in machine code. Take a look at the following statement:

LDA SCREEN,Y !LET A=SCREEN+Y

The comma is the equivalent of a plus sign, so if SCREEN was equal to $D800 and the Y index equal to #$5 then the accummulator would be loaded with the content of location $D800 plus #$5. The first argument will always be a memory location (or a label representing a memory location), and the second argument an index (that is, either X or Y). All you have to remember is to think of the comma as a plus sign; why a plus sign isn't used is just one of life's little mysteries. (NB: Some assemblers use a semi-colon ';' in place of a comma: if your assembler is one of these, remember to change all commas to semi-colons).

Using this form of LDA statement, we can point at up to 255 locations after the label simply by increasing the X or Y index. This type of addressing is known as Absolute Indexed Addressing and is the first type of indexed addressing we shall use. To see how this works, let's take a look at our MACHINE CODE SPACE PROGRAM.

*** = $C000**

This tells the assembler to place the program at $C000. You'll probably be tired of us telling you this so we won't remind you in future.

LDA #$20

Load the accumulator with #$20 (32 decimal).

LDX #$00

Load the X index with zero.

LOOP STA $0400,X

Assign the label LOOP to this line so that we can branch back to it later. STA $0400,X adds the value of the X index to $0400 and stores the content of the accumulator in this memory location. Thus on the first pass of the loop, the value of the accumulator ($20) is stored at $0400 + $00 = $0400 (the start of screen RAM).

INX

Increase the X index by one.

CPX #$C8

Compare X to #$C8 (200 decimal).

BNE LOOP

If X is not yet equal to 200, branch back to the line labelled LOOP. Otherwise continue.

RTS

The loop is complete, so exit to Basic.

The program places the value $20 (decimal 32,

ascii space) into the first 200 locations of screen RAM. In other words, we fill the first five lines of the screen with spaces — exactly as the BASIC SPACE PROGRAM did. A flow diagram is given with the listing.

Since there are instructions to increase the values of the X and Y indices, it seems likely that there are corresponding instructions to decrease the values. These take the form DEX, DEcrease X, and DEY, DEcrease Y. Let's see how these might be used. Take a look at the YELLOW SCREEN listing. This uses indexed addressing to turn all the characters on the screen yellow.

```
* = $C000
COLSCREEN = $D800
```

Define the label COLSCREEN as the start of colour RAM.

```
LDY #$00
```

Load the Y index with zero.

```
LDA #$07
```

Load the accumulator with #$07 — the colour code for yellow.

```
LOOP STA COLSCREEN,Y
```

Add the value of the Y index to $D800 and store the value of the accumulator at the resulting address.

```
STA COLSCREEN+256,Y
```

Add the value of the Y index to COLSCREEN + 256 and store the value of the accumulator at this address.

```
STA COLSCREEN+512,Y
```

Add the value of the Y index to COLSCREEN + 512 and store the value of the accumulator at this address.

```
STA COLSCREEN+744,Y
```

Add the value of the Y index to COLSCREEN + 744 and store the value of the accumulator at this address.

```
DEY
```

Decrease the Y index by one.

```
CPY #$00
```

Compare the value of the Y index to zero.

```
BNE LOOP
```

If the Y index has not yet reached zero, branch back to the line labelled LOOP.

```
RTS
```

The Y index equals zero, so exit to Basic. In other words, each location in colour RAM is set to 7, the colour code for yellow. Thus everything on the screen will change to yellow. How many times when writing Basic programs have you wished you could instantly turn the screen yellow? The best way to see exactly how the program works is to run it. To do this, assemble the program, return to Basic and SYS 49152.

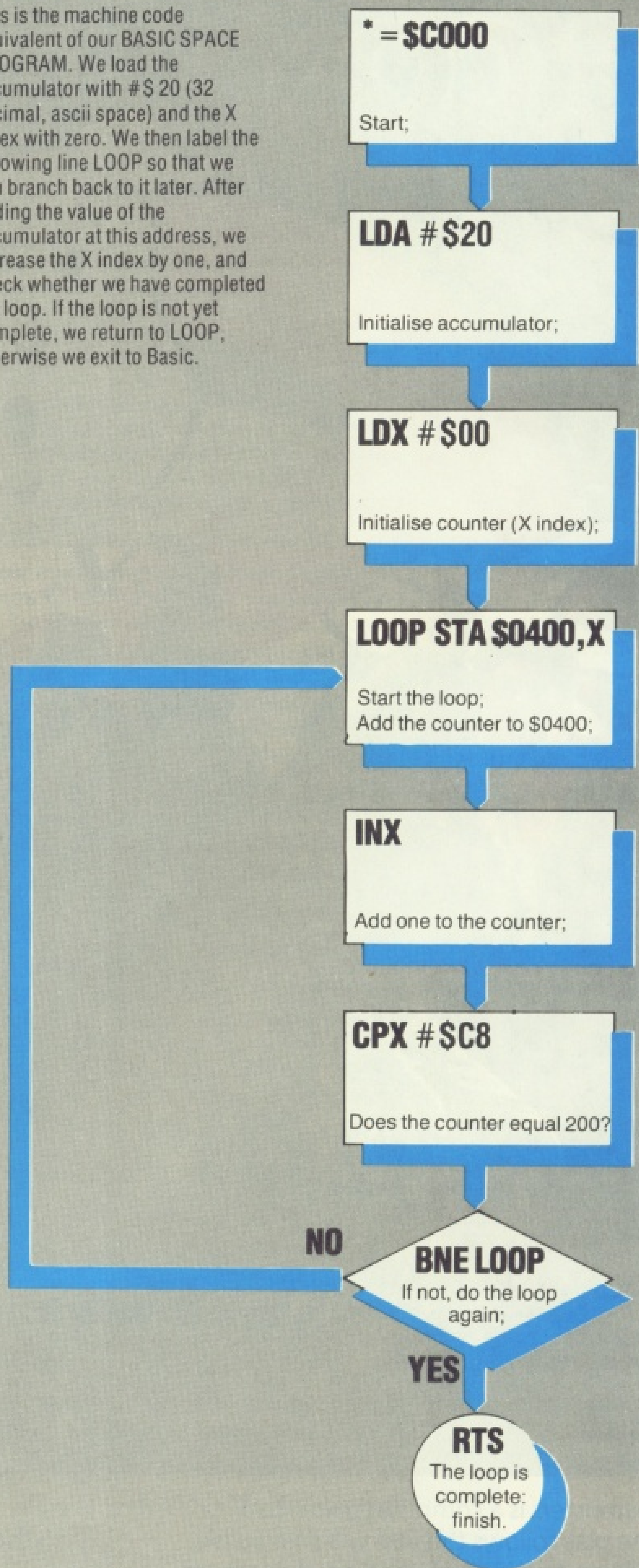
Binary

Most work in machine code is performed in hex (base 16). Some aspects of machine code programming, however, are easier using binary (base 2). A good example is manipulating the sprite registers. Manipulation of binary values is known as bit manipulation, since you are working with BInary digiTS. Bit manipulation is something we'll examine mine next month. If you're not familiar with binary, read through the BINARY NOTATION box now.

Just as hex numbers are preceded with a '$', so binary numbers are preceded with a '%' sign. Thus %01000001=$41=65 (=ascii "A"). Some assem-

MACHINE CODE SPACE PROGRAM: FLOW CHART

This is the machine code equivalent of our BASIC SPACE PROGRAM. We load the accumulator with #$ 20 (32 decimal, ascii space) and the X index with zero. We then label the following line LOOP so that we can branch back to it later. After adding the value of the accumulator at this address, we increase the X index by one, and check whether we have completed the loop. If the loop is not yet complete, we return to LOOP, otherwise we exit to Basic.



BASIC SPACE PROGRAM

```
100 B = 32
110 I = 0
120 POKE 1024 + I, B
130 I = I + 1
140 IF I <> 200 THEN 120
150 END
```

A Basic program to fill the first five lines (200 characters) with spaces. This is obviously not the most efficient method of doing the job, but is closest to the way the task is approached in machine code.

GHOSTBUSTERS™ THE COMPUTER GAME.

BY DAVID CRANE



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blers allow you to work directly in binary, but with most you have to convert all values to hex. We've already given you a three-line (not two, as we stated in the caption!) decimal to hex converter; next month we'll give you a binary to hex converter.

Flags

When we use a CPX or CPY instruction, the 64 sets a 'flag' to tell it the result of the comparison. In 6510 assembly language there are seven different flags in all, with corresponding instructions to act on the setting of these flags. We've already looked at BEQ (Branch if EQual) and BNE (Branch if Not Equal): these instructions check the Z (zero) flag. If the last CMP instruction tested two equal values, the Z flag is 1 otherwise (if not equal) it is set to zero. During the series we will examine each of the other six flags, starting here with the C (carry) flag.

Just as the Z flag is used to test for equal/not equal cases, the carry flag is used to test for greater than/less than. We test for a 'less than' case by the BCC (Branch if Carry Clear) instruction and for a 'greater than' case using BCS (Branch if Carry Set). We'll see how these instructions work later in the course, but an easy way to remember the difference between the two for now is that the 'C' in BCC is less than the 'S' in BCS.

Here's a simple example:

```
LDA SCREEN
CMP #$08
BCC LESSTHAN
RTS
```

If location SCREEN is less than #$08, the program branches to the label LESSTHAN. If SCREEN is greater than or equal to #$08, the program exits to Basic.

To test for a 'greater than' case, simply change the third line to read BSC GREATERTHAN to jump to the label GREATERTHAN. Don't forget that there are three possibilities in any comparison: greater than, less than and equal. You can also test for *either* less than *or* greater than using BNE. To summarise:

BEQ = Branch if the accumulator and CoMPared value are EQual.
BCC = Branch if the accumulator is less than the CoMPared value.
BSC = Branch if the accumulator is greater than the CoMPared value.
BNE = Branch if the accumulator and CoMPared value are Not Equal.

Homework

Whenever you get the chance, take a look at other people's programs: you won't understand all of them, but treat it as a challenge to see how much you can figure out based on what you know so far. This is one of the best ways of learning.

Two parts to this month's homework. First another purchase, I'm afraid, but you'll find it an invaluable aid to both Basic and machine code programming. This is Commodore's *Programmers' Reference Guide*. Unusual as it is to be able to praise a Commodore manual, this one really is essential to machine code programmers. It costs £9.95 from Commodore dealers and some bookshops.

The second (and more interesting) task is to write a program to display the complete upper-case character set on the screen in yellow! By complete upper-case character set, we mean capital letters, numbers and graphics characters — all the characters you have access to on power-up. To do this, you'll need to know two more instructions: TAY and TYA. TAY stands for Transfer Accumulator to the Y index, and TYA is the opposite — transfer the Y index to the accumulator. These do exactly what they say: TAY makes the Y index equal to the current value of the accumulator, while TYA makes the accumulator equal to the current value of the Y index. TAX (if you'll excuse the expression) and TXA are the X index equivalents.

If you're wondering how these will be used, remember that you cannot directly increase the value of the accumulator. A little thought should provide you with an efficient approach to the problem. Answer next month.

A PROGRAM TO TURN THE SCREEN YELLOW

```
* = $C000                 !Program start at $C000

COLSCREEN = $D800         !Define label COLSCREEN

LDY #$00                  !Zero Y index
LDA #$07                  !Make Accumulator equal to #7 -Yellow

STA COLSCREEN,Y           !
STA COLSCREEN+256,Y       !Accumulator is still = #$07
STA COLSCREEN+512,Y       !
STA COLSCREEN+744,Y       !

DEY                       !Decrease Y by one
CPY #$00                  !Compare Y to zero
BNE LOOP                  !If not equal, branch to LOOP
RTS                       !Return to Basic
```

You may recognise this as the assembler equivalent of listing 2 in part 1 of the series (issue 2, p35). After defining COLSCREEN as the start of colour RAM ($D800), setting the Y index to zero and the accumulator to $7 (the colour code for yellow), the program colours the screen yellow by four concurrent loops.

The four loops each cover 25 per cent of the screen. The Y index starts at zero and is decreased by one during each pass of the loop (the first decrease from zero will cause it to 'roll over' to 255). DEY performs the decrease, CPY #$00 checks whether the value has reached zero: if it has, the program returns to Basic, if not it loops back to the LOOP label.

Back Issues

If you've missed earlier parts of the series, back issues of the magazine are available for £1.10 inclusive of post, packing and handling. Send a cheque or postal order payable to Sportscene Specialist Press stating which issue(s) is/are required, or use the coupon elsewhere in this issue. Remember that the series is one stage behind the issue number, so part 1 of the series is in issue 2 and so on.

Next month: Arithmetic

- Addition & subtraction
- More addressing modes
- Binary to hex converter program
- Using machine code from within Basic (SYS and USR)

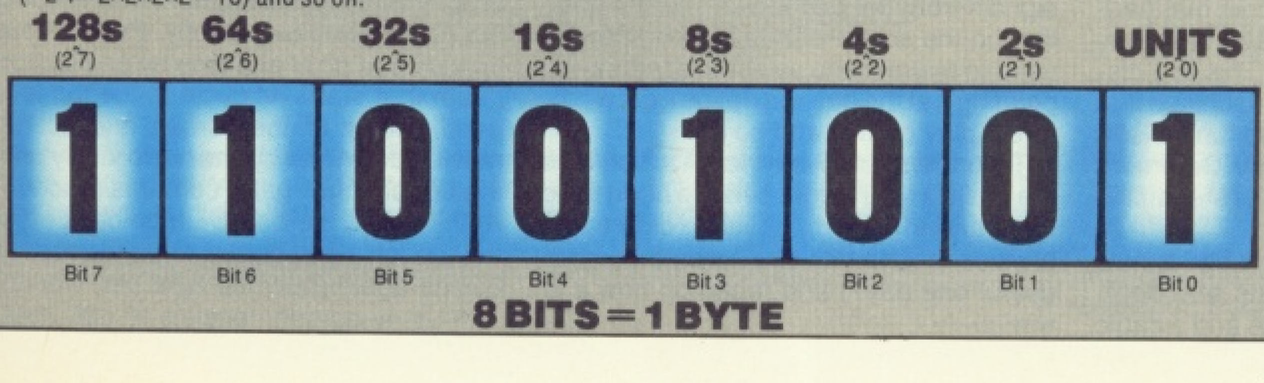
BINARY NOTATION

Although hexadecimal notation is used for most machine code work, some tasks are best performed in binary. Just as hex is base 16 arithmetic, binary is base 2: that is, the only digits allowed are zero and one.

One byte is eight bits (Binary digITS). The first bit (bit zero) represents units (1); bit one is the base (two) to the power two (= 2^2 = 2×2 = 4); bit two is two to the power three (= 2^3 = 2×2×2 = 8); bit three is two to the power four (= 2^4 = 2×2×2×2 = 16) and so on.

Thus the number shown is converted to decimal as follows:

11001001 binary =
(1×128)+(1×64)+(0×32)+(0×16)+(1×8)+(0×4)+(0×2)+(1×1)=
128+64+0+0+8+0+0+1=
128+64+8+1=
201 decimal



THE LIGHT TOUCH

The light pen has been around for many years, but it's only recently that manufacturers have realised its potential in the home computer market. Valerie Buckle *explains how a light pen works, and experiments with packages from Futurehouse and Stack.*



JANOS MARFFY/THE HOME COMPUTER COURSE

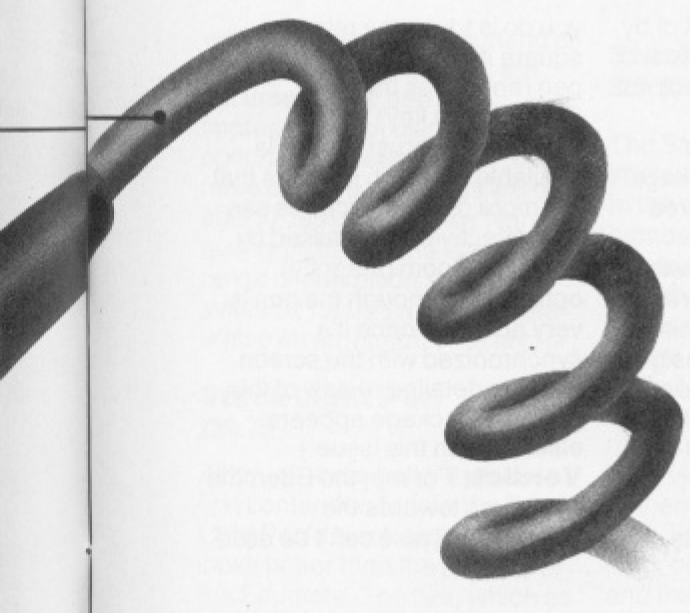
The 64 is an ideal partner for a light pen since the control circuitry is already built into the VIC chip (the chip that handles the display). All you need do is buy the pen itself and plug it in. This is a distinct improvement over the machines that demand you open them up and insert extra (and expensive) circuitry. Before we look at specific examples, let's examine the way a light-pen works.

A light pen is a remarkably simple device. In outline, it consists of a light-sensor in a pen-shaped tube and a cable to feed signals into the 64 (see main illustration). The pen is pointed at the screen, and the VIC chip in the 64 uses the signals from the pen to work out its position on the screen. Thus the pen can be used to make menu selections (simply by pointing it at the desired option), draw pictures, play games and so on.

To understand how the 64 calculates the position of the light pen, we need to go back to our 'O' level physics (didn't your physics teacher tell you it would come in useful one day?) and recap on how a tv works.

The main element in a television set is a cathode-ray tube (CRT). This comprises an electron emitter and a screen coated on the inside with phosphor. When struck, the phosphor glows briefly. Pictures are built up one pixel at a time by an electron beam that starts its cycle at the top left-hand corner of the screen and scans, moving down line by line horizontally until the bottom right-hand corner is reached. At this point, the beam jumps back up to the top left-hand corner and the process begins again (how the light pen works).

A UK tv screen consists of 625 lines,



and the beam scans at the rate of 50 lines per second. Thus a single screen-refresh takes about 1/25th of a second. We don't see the beam moving across the screen because the human eye is normally incapable of decoding anything visible for less than 1/16th of a second — so to all intents and purposes we're seeing an unbroken picture.

Now, while the human eye cannot detect the electron beam, a photo-detector can. The detector senses the light from the pixel and emits a sharp pulse current — which is amplified and passed to the computer. Having now detected the presence of the beam, the next step is to discover its whereabouts on the screen. This is achieved through measurement of the period that elapses between the electron beam leaving the top left of the screen and it reaching the light pen. The 64 does this by starting a timer at the beginning of the screen refresh, and stopping it when the light pen detects the beam. Given that we know the rate of scan and the time taken to reach the pen's position, it's a simple matter for the machine to calculate the x,y coordinates of the pen.

For example, if the beam takes 32 microseconds to cross each line of the screen, and the time taken to reach the pen is 2470 microseconds, we can calculate the pen's y coordinate as follows:

y=INT(2470/32)=77

The x coordinate is simply the non-integer part expressed as a percentage — that is:

x=100*((2470/32) — INT(2470/32))=18.75

Thus the x coordinate is 18.75 per cent across the screen (that is, column 60).

In practice, the VIC chip does this job for us automatically, placing the x and y coordinates into memory locations 53267 and 53268 respectively. These are updated 50 times a second, so all we need to do is PEEK these locations to find out where the pen is at any given moment.

The coordinates obtained in this way aren't yet entirely accurate; when using the light pen from a program, we have to take into account the fact that there's a border around the working area of the tv screen or monitor. Thus we have to reduce the visible area of the screen by units (which, for the sake of convenience, we'll calculate in pixels) representing the amount lost to the border. As all tv screens are slightly different, an easy way to calibrate these values on your screen is to type in and run this one-line program:

```
10 PRINT PEEK (53267), PEEK (53268): GOTO 10
```

Place your light pen on the tv screen pointing exactly to the top left-hand corner of the blue background area. The screen will display two sets of numbers, the left-hand column indicating the value of the horizontal position of the pen (x), and the right-hand column the vertical (y) position. When these values become steady, just note those most commonly shown in each column (on my tv these were 28 and 50).

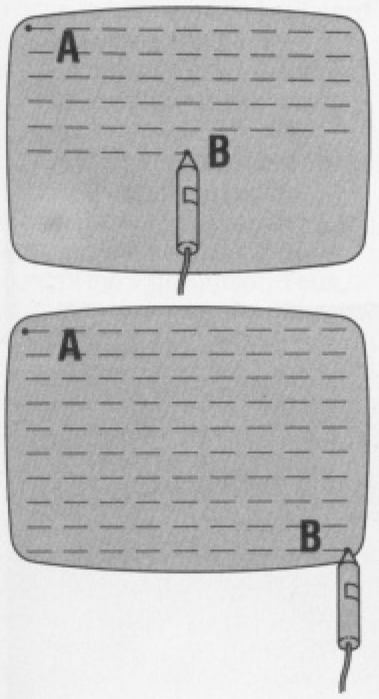
These are the offsets between the visible screen and the actual screen and must be taken into account in all your programs — otherwise the light pen will not be accurately synchronised with the screen. Furthermore, because the memory locations are 8 bits, we can only store numbers from 0 to 255. This is fine for the y coordinate, but the x coordinate may go up to 320. Commodore chose to solve this problem by displaying a number that's half the actual coordinate. Therefore, when programming, the x value obtained from the VIC chip must be multiplied by 2 in order to arrive at the actual number.

Here's a simple example of how to use a light pen from Basic, using the knowledge you now have. This short program (using BC Basic) will allow you to draw on your screen with any kind of pen:

```
10 MODE 3,0:CLG
20 X=PEEK(53267)-28:Y=PEEK(53268)-50
30 DRAW TO X*2,200-Y
40 GOTO 20
```

this can easily be translated into most extended Basics.

HOW THE LIGHT PEN WORKS



The way in which the computer can tell the position of the light pen is to start a timer when the electron beam leaves the top left hand corner of the screen (A) and then stop the clock when the beam reaches the pen (B). The computer then calculates the pen's position from this time.

For example, if the beam takes 32 microseconds to cross each line of the screen, and the timer reads 2470 when the beam reaches the pen, the pen's position is calculated as follows.

The y coordinate is simply:

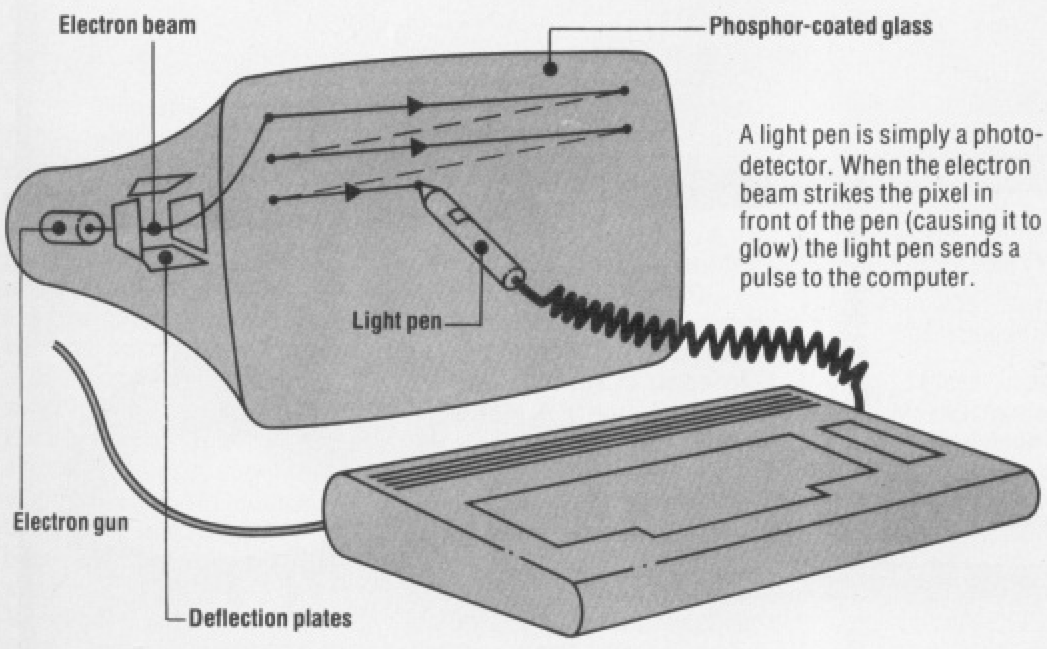
INT (timer reading/32)
=INT (2470/32)
=77.

The x coordinate is the remainder expressed as a percentage, that is

100*((2470/32)-y)
=100* (77.1875-77)
+18.75% of the screen width
=18.75% of 320
=60

In practice, the 64 does these calculations for us, so the current y coordinate is PEEK (53268) and the x coordinate 2*PEEK (53267). The x coordinate is stored as half its actual value since 8-bit memory locations can only store numbers up to 255.

Unlike many machines, the 64 contains all the necessary light pen decoding software in the VIC chip, so no extra interfaces are necessary.



A light pen is simply a photo-detector. When the electron beam strikes the pixel in front of the pen (causing it to glow) the light pen sends a pulse to the computer.

A tv or monitor is essentially nothing more than a cathode ray tube. Electrons are fired at the centre of the screen by the electron gun. The magnetically-charged deflection plates deflect the path of these electrons, starting at the top left hand corner of the screen and working horizontally down to the bottom right. When an electron strikes the phosphor coating on the inside of the screen, the pixel 'flares' briefly. To refresh the whole screen takes about 1/25th of a second.

MARK WATKINSON

JANOS MARFFY/THE HOME COMPUTER COURSE

PENS IN PERSPECTIVE

Y64 focusses on three light actuated devices — each representing a variation on the light pen theme.

Edumate Light Pen

£34 (pen only); £59.95 (pen plus Peripheral Vision)

Produced by Futurehouse, the Edumate light pen is maroon, slimmer than most and feels more like an ordinary pen than the light sensitive variety. The flex tends to wrap itself around your hand whilst in use (a criticism which applies virtually across the board). I suspect this is mainly due to the fact that the coiled lead comes out of the top of the pen. Another factor here is that the lead itself is too short, a fault which will mostly concern those who use their machine with a standard television screen.

The small duplicated manual which accompanies the device explains how it works, how to use the pen with Commodore Basic, and outlines the four free programs on the diskette which comes with the package. There's also *Peripheral Vision*, a graphics package which is optionally available for the Edumate.

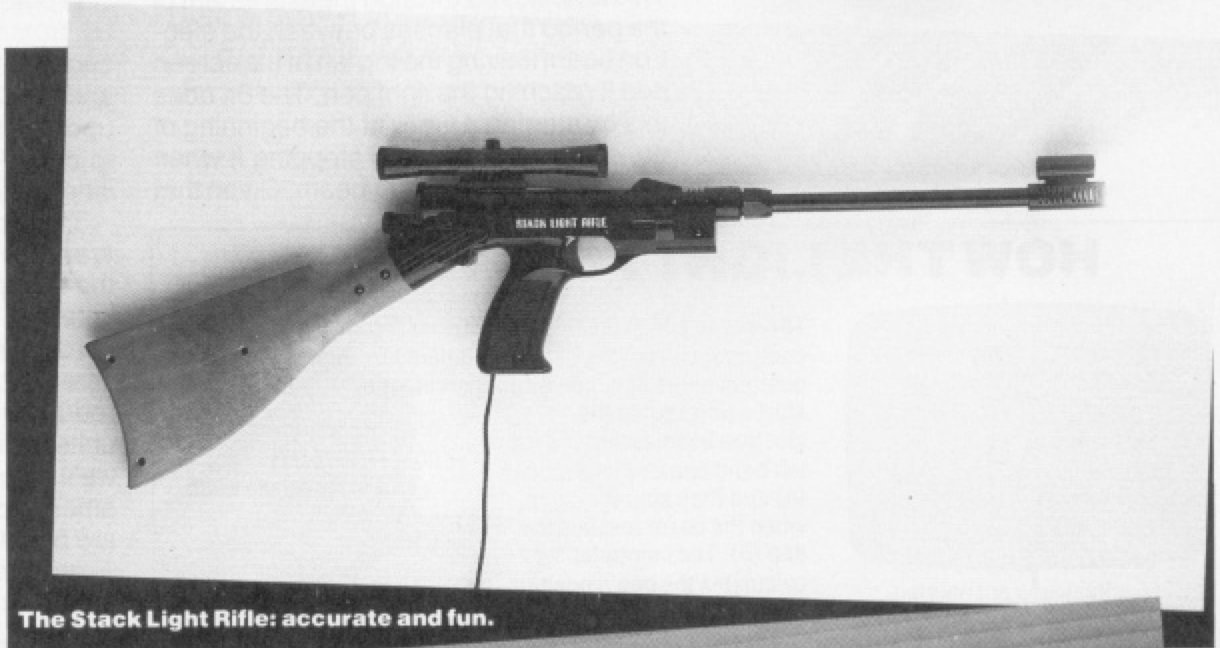
Although somewhat limited in complexity, the standard programs give a fair indication of the light pen's range of use. The draw routine allows you to draw freely on your television screen or monitor in a variety of colours — a nice introduction to the creativity possible using a light pen rather than cursor control. There's also a disk utility program, a 3D game of *Tic Tac Toe*, and a program for composing tunes on your Commodore 64, simply by touching the notes with the light pen.

To get the pen operational, all you have to do is plug in and load the appropriate software. To activate the Edumate, you point the pen at the screen and hold down either the F7 or Commodore key ... there's no trigger on the pen itself. This soon gets tiring and may even induce a major reshuffle of your system, to leave your normal writing hand free for drawing. This is, frankly, a nuisance, that should have been thought of by the designers; aching arms and constant rearrangement are not likely to endear anyone.

The optional *Peripheral Vision* is a graphic art package with all the standard features one would expect from a drawing program and allowing full colour pictures to be created using the light pen. With this package you're able to design your own textures (or choose from a range already available), draw freehand in a variety of colours, use pre-defined shapes, and fill, zoom or activate many other effects. All you do is touch the relevant square in the menu with the light pen (and press the F7 or Commodore key).

A range of brush widths is available although it seems that the more detailed pictures can only effectively be realised by using the Zoom (magnify) option, even though the pen is very accurate once it's synchronized with the screen. (A more detailed review of this graphics package appears elsewhere in this issue.)

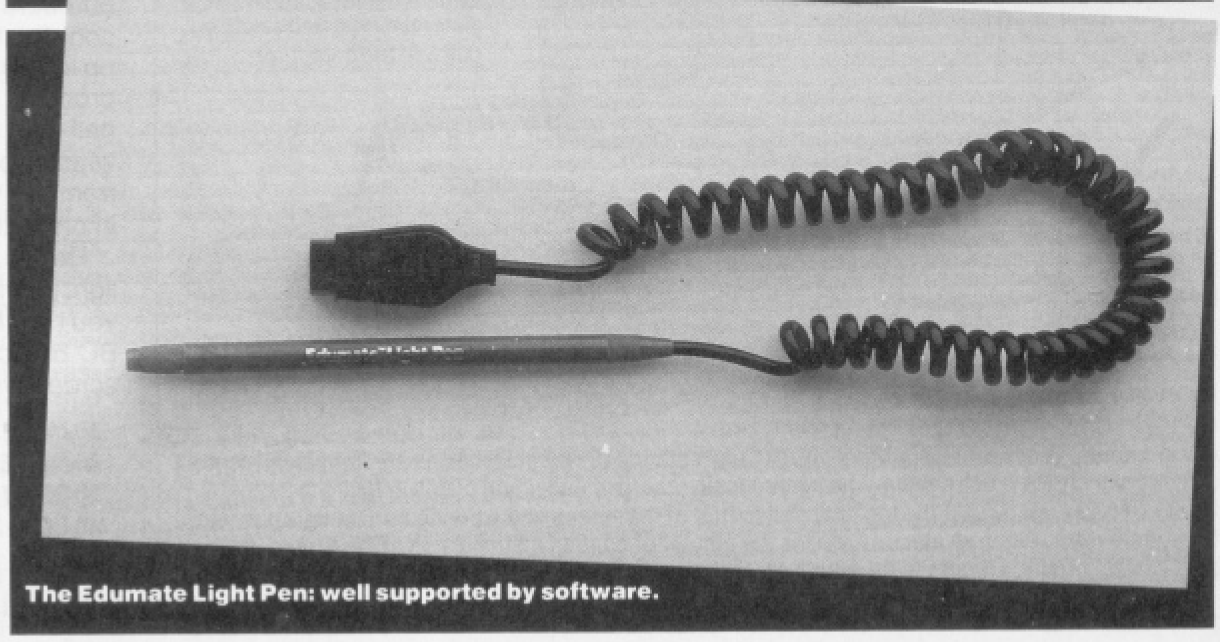
Verdict: For me, the Edumate pen veers towards the expensive; it also can't be used



The Stack Light Rifle: accurate and fun.



The Stack Light Pen: inexpensive, but inaccurate.



The Edumate Light Pen: well supported by software.

IAN McKINNELL

with packages which demand a trigger feature. However, the accuracy of the pen is impressive and, using the optional *Peripheral Vision*, the more creative among us will be able to design and draw high quality pictures. The large range of education software available for use with Edumate is also an argument in its favour.

Stack Light Pen
£28.75

Although more bulky than our first contender, for me the Stack Light Pen's black and silver trim looks better than the maroon of the Edumate. The flex, which as usual comes out of the top of the pen, connects to the 64 via a small box packed full of mysterious electronic gadgetry — which fits snugly into the joystick port. As with the Edumate, the flex is not long enough to allow sufficient distance between the keyboard and the screen and there's the same tendency to wrap around your arm while you're moving the pen.

The Stack device has one major advantage over the Edumate — it features a touch contact which allows you to control the light sensor. Thus, instead of pressing the F7 or Commodore key, all you do to activate the Stack pen (after plugging in and loading the appropriate software), is lightly press the silver bands touch contact — allowing total control with just one hand.

The manual supplied with the Stack pen explains how the device works and how to use it with Commodore Basic. The text seems rather confusing in places ... particularly in the way it swaps between VIC-20 and Commodore 64 commands — often with no explanation whatsoever.

The free cassette game, *Concentration*, which accompanies the pen is of no lasting interest and doesn't do much to help you explore the pen's capabilities. However, using the Stack pen with *Peripheral Vision* showed it was about as accurate as Edumate once it had been carefully synchronized with the screen. But when I duly typed in the 'plot a square' program listed at the end of the light pen manual, there seemed little relation between the position of the pen and the square that appeared.

Verdict: More attractive than the Edumate, and less expensive, I particularly enjoyed the freedom of movement made possible by the trigger feature. However, the loss of accuracy from Basic spoiled an otherwise excellent package.

Stack Light Rifle
£29.95

The Stack light rifle is an impressive and fun alternative to the common-or-garden games joystick. The rifle allows you to sit back from the screen and shoot away at targets, thus bypassing the often clumsy nature of the fire button.

It's light to handle, about three-quarters the size of a real rifle, comes with a telescopic-style viewfinder and looks very authentic in black with brown trim. The lead, about twelve feet long, plugs into the joystick port and there's also a short extension which inserts into the user port at the rear of the 64. This may be because the light rifle is sensitive to colour, rather than light intensity. (Unfortunately, there's not much information on this in the instruction leaflet).

Because the rifle is colour sensitive, your television or monitor may well need adjusting for maximum colour visibility. Similarly, the distance you can shoot from will depend on the quality of your television picture. According to the information supplied, eight to twelve feet can be achieved on most models; I found I was able to shoot accurately with the lead fully extended to twelve feet.

The rifle comes supplied with three games on cassette and the leaflet assures that may others are available. *High Noon* features a desert terrain with hills and a stash of dynamite. Your task is to shoot the man who runs onto the screen before he reaches the dynamite; he appears from several different locations and at random. I found that, while pointing to the upper part of the screen, the lower part was often obscured, leaving me unaware of danger until the very last moment.

The other two games are similar tests of speed and accuracy. *Glorious 12th*, a celebration of the first day of the grouse shooting season, demanded greater speed and accuracy than I was able to muster, even at the lowest of low levels. *Gallery* is reminiscent of the early *Pong* games, with gradually widening goal posts which swallow the target if you fail to shoot it first.

Although these games are uncomplicated and use simple graphics they're still effective and give a good idea of the fun that's to be had.

Verdict: Terrific value for money for those who enjoy playing aggressive games. I found the rifle easy to use and seasoned addicts assure me it's very accurate.

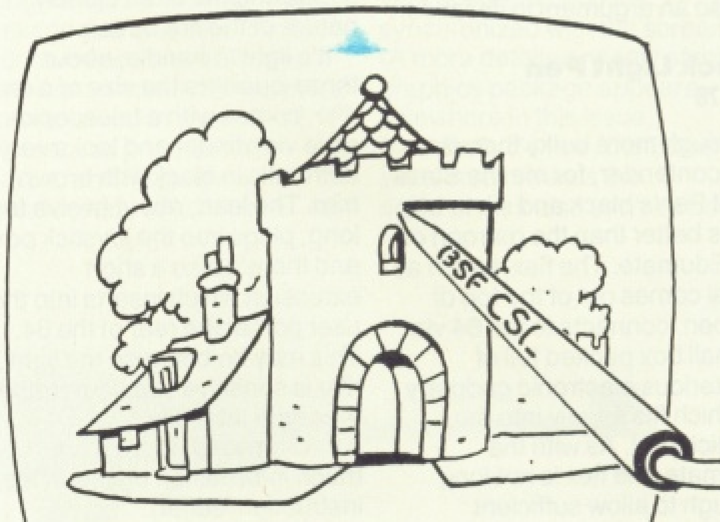
19

A FREE LIGHTPEN

Yes a FREE Light Pen! with every **GRAPHKIT**! Graphkit is the ultimate in drawing!, designing! or painting! (using the light pen of course, which incidentally has a full 3 year warranty!) Graphkit will amongst other things allow you to:

- Draw free handed on the screen anything from a Micky Mouse to your latest integrated circuit! With all the fill colour and erase facilities of course!
- Save/load your latest master piece to/from the disk/tape drive
- Or directly copy the drawing on the screen to the printer! And keep it for ever or send to a friend as a post card!
- Design your own colourful sprites and characters
- Play the games in the package! or use the light pen in your own games/education/programs

GRAPHKIT is available on disk and tape. Tape version is £1595 and disk version (recommended) is £19.95.



All you 1540/1541 disk users **DMON**! Is here at last. Dmon is the disk monitor you have been waiting for it will allow you to:

- read/write blocks from/to the disk
- display and edit blocks on the screen
- display and send disk messages/commands
- transfer your programs from tape to disk or disk to disk or even disk to tape! • and more!

DMON comes on DISK at only £9.95.

Do you use tapes? Are you sick and tired of waiting for your programs to be Loaded/Saved from/on the tape? Then you need a **TORNADO**!! Tornado allows you to Save/Load/Verify your Basic/machine code programs faster than a CBM 1541 disk drive does! Due to popular demand! Tornado now comes with new and more powerful commands plus extra instructions to assist you in making fast versions of your existing machine code/Basic programs. Tornado is available on tape for CBM 64 and 8K + Vic 20.

Do your Run/Stop and Restore keys often fail? Do you want to come out of those crashes?! Or get into those unbreakable programs?! Then what are you waiting for, get yourself a **BREAKER**!! Reset switch and let your computer know who is the boss!! Breaker can be connected to your machine in seconds, no soldering. Included with the Breaker is a copy of basic recovery software on tape. Now available for any CBM 64 or Vic 20.

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Please send me ....Graphkit at £15.95 (tape)

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Please send me ....DMON at £9.95

I enclose cheque/PO/cash to the sum of £..................

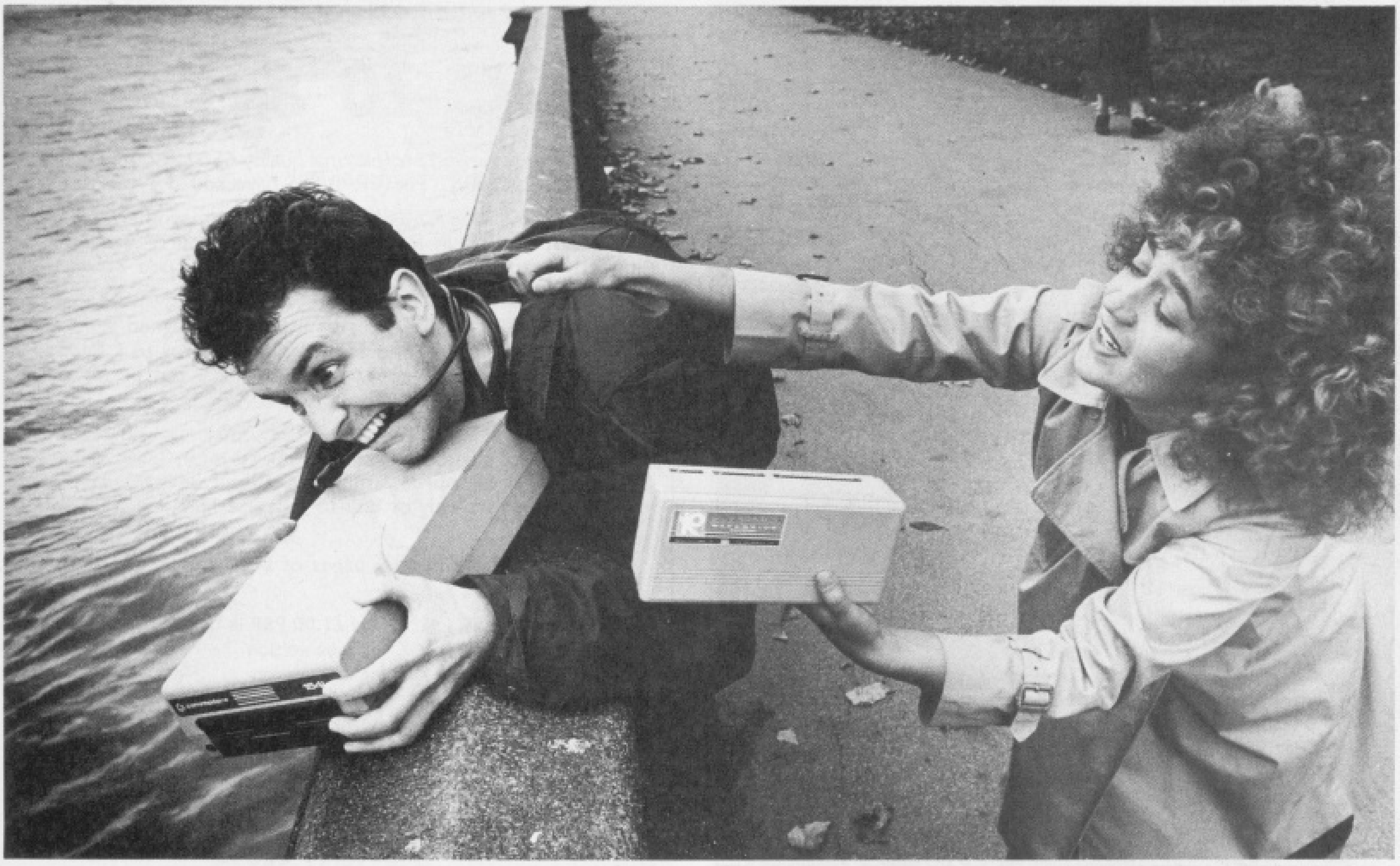
Name..........................Computer..........................

Address...

....

Please use this form and block letters only. All prices are inclusive of p&p (mail order only, add £2 if outside UK). Please post to:
BSF CSL, 82 FURNACE DRIVE, CRAWLEY, WEST SUSSEX RH10 6JE.

END THOSE 1541 BLUES...



Can you afford to miss your chance to win Rotronics' answer to the 1541? There're 25 Wafadrives up for grabs in our easy-to-enter competition.

Rotronics' Wafadrive is a full expansion system for the 64. Apart from providing an alternative stringy/floppy storage system, it also includes full RS232 and Centronics interfaces. The facilities incorporated into the Wafadrive can all be accessed from Basic.

Interested? Well, *Y64* just has to give away 25 of these miracle boxes to the lucky winners of our compo this month.

HOW TO ENTER

It's a giveaway! All you have to do is put the list of the Wafadrive's features in the appropriate order of importance. For example, if you reckon that (b) *Attractive, self-contained unit* is the most alluring feature (and why not, it's a damn pretty machine — Tech. Ed.), put this as number one on your list. This done, tell us in not more than 12 words why you think a Wafadrive would complement your 64 system.

GROUNDRULES

1. The decision of the judges is final. No correspondence will be entered into.
2. Entries which are illegible, incomplete or do not fully satisfy these rules will be disqualified.
3. All materials will be retained and may be published without further permission.
4. All entries must be received by 20th January 1985.

THE CRITICAL BIT

What's so special about a Wafadrive? Simply sort these attributes into descending order of indispensability (I think tha means put them in the right order-Ed.):

a. Centronics and RS232 ports as standard
b. Attractive self-contained unit
c. 'User-friendly' syntax and interface
d. Free wordprocessor program
e. Twin drives
f. Inexpensice cartridges
g. Fast access to files and programs
h. Software available in wafer form
i. Highly reliable data storage
j. Superb documentation

COMPETITION

My favourite features, in order of importance, are:

1☐ 2☐ 3☐ 4☐ 5☐

6☐ 7☐ 8☐ 9☐ 10☐

I'd like a Wafadrive because ....

....

....
(not more than 12 words)

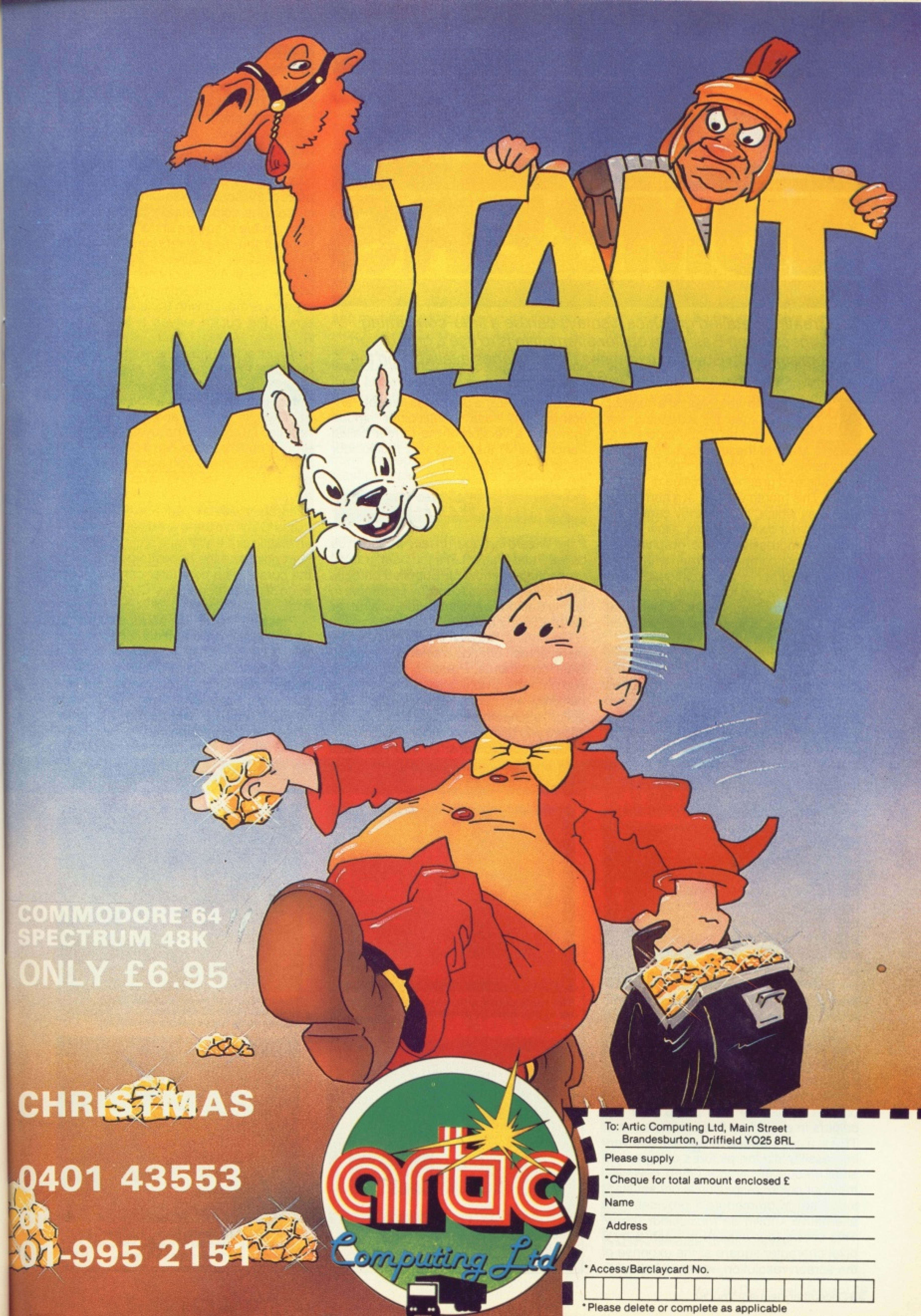
Name ....

Address ....

....

.... Postcode ....
Use a photocopy if you want to keep your magazine intact:

Make sure you've not missed anything — a careless mistake could cost you your Wafadrive — then stick it in the post to *Y64 Wafadrive Competition, 14 Rathbone Place, London W1P 1DE.* All entries in by 20th January 1985 please!


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PAINTING BY NUMBERS

Creating detailed graphics displays can be a time-consuming business using Basic. An easier alternative is to use a graphic art program. Keith Bowden *examines the packages available on the 64.*

Last month we looked at a number of packages for extending the Basic on the Commodore 64. Many of these included graphics statements allowing you to use the sophisticated graphics facilities of the 64 easily. This month we look at a number of packages which, though they cannot be used via your own programs, allow you to produce impressive static graphic displays on your computer screen with ease. Known as graphic art packages, these programs allow you to draw on the screen with such peripherals as light pens, bit pads, joysticks, or just the cursor keys on the computer keyboard.

My own experience with input devices is that light pens and bit pads allow the user to be most creative but are not as accurate as might be desired. A zoom facility, in which parts of the picture are magnified for easy editing, is essential with these. Joysticks are fast and accurate but, until analog devices are more generally supported, only allow drawing in eight directions. This is also true of the majority of cursor key control arrrangements, which tend to be more accurate but much slower to use.

While testing out the packages described below I've been looking at a number of graphic art packages for professional use, most of them based around the Pluto graphics board and in the £10,000 price range. My conclusion is that there is little difference between the programs available for the Commodore 64 and the 'professional' setups, other than in screen resolution (a good graphic art monitor allows a resolution in the order of 1000 by 700 with upwards of 256 colours on screen). Indeed in many cases the programs I looked at for *Y64* were superior. The high resolution graphics screen on the Commodore 64 allows 16 colours in 320 by 200 pixels with two colours in each 8 by 8 character square. This is a compromise which leads to very impressive looking pictures using only a small amount of memory. Often, however, the poor colour resolution is not satisfactory so Commodore provides an alternative known as multicolour mode. This allows four colours in each 8 by 8 pixel character square at the expense of the screen resolution, which is halved to 160 by 200. All the packages except Panorama (H) use multicolour mode (however a version of the former called Panorama(M) that does use multicolour mode is also available).

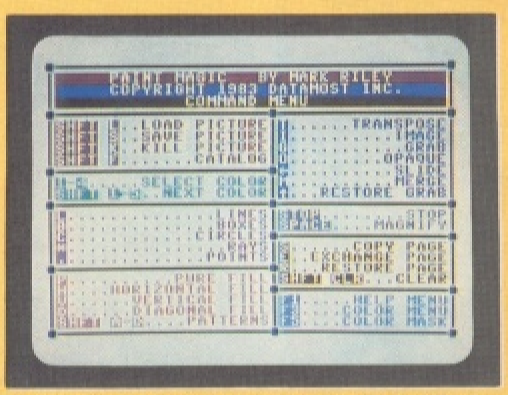
●Paint Wizard

Paint Wizard is magic (in fact, it used to be called Paint Magic!). It's the best graphic art package I know of. Supplied on disk, the package is produced by Datamost in sunny California and imported, at a rather steep £36, by Softsel.

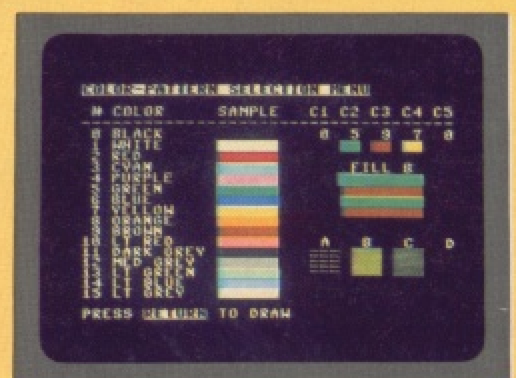
On loading, the user is presented with a menu screen offering a selection of single letter commands. Pressing return takes you onto the graphics screen where you can draw with cursor keys or joystick. The action is smooth and quick. Paint Wizard allows you to draw on either of two multicolour mode screens, so you can have two pictures on the go at once without resorting to disk. Loading pictures from the selection provided on the disk shows just how convincing multicolour mode on the Commodore 64 can be. Cats, girls, sunsets, waves, all beautifully drawn, usually in four colours, but sometimes more. Paint Wizard offers a facility for changing the default colours at specified parts of the screen. A square box-shaped cursor (the colour mask) can be moved from square to square under joystick control and the three foreground colours in that square redefined. Blanking the screen again gives a chance to see what we can do with the ordinary cursor. If the joystick is moved with the firebutton held down, the cursor leaves a trailing line. Releasing the fire button allows it to be moved freely around the screen without drawing. Pressing the 'L' key gives an elastic line. On moving the cursor, one end of the line stays attached to the point at which it started, and the other end remains attached to the joystick. It moves around and stretches like a piece of elastic. Choose where you want the line and press the 'L' again to drop it off. This allows lines of any angle to be drawn accurately with an eight position joystick. Press 'C', move the joystick, and you have an elastic circle, with one point fixed to the start point and the opposite point fixed to the cursor. The perimeter can go off the edge of the screen. Press 'C' again to drop it off.

Pressing the 'P' key starts a fill (paint) routine from the current cursor position in the current paintbrush colour to any closed boundary in any other colour. It is a perfect 'diamond' fill routine and the fastest one I have ever seen. 'M' gives a 'merge' fill. The picture on the other screen is bled through into the area to be filled. At the same speed as before.

●Paint Wizard



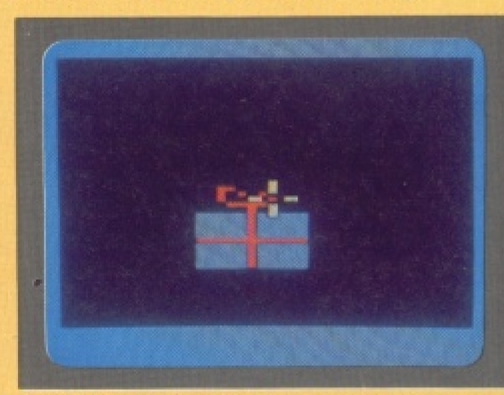
The main command menu can be called up at any time by pressing F7.



The colour and pattern menu is accessed from the main command menu. You can see exactly what you're choosing.



The joystick is used repeatedly to copy the ball onto the tree.



Pressing the space bar magnifies the screen by a factor of eight, allowing detailed work on small objects.

●Peripheral Vision



An otherwise excellent package is spoilt somewhat by the extremely poor manual.



Peripheral Vision **is completely icon-driven, the light pen being used to point at the desired option.**

SHIFTed 'A', 'B', etc, give textured fills with user-defined fill patterns. The stop key aborts the current command.

'B' defines an elastic box. 'I' gives an elastic box that defines an area of the screen to be moved. Press fire to fix the size of the box, move the joystick and the box follows. Press fire again and the enclosed area is copied onto the new position. 'T' is a similar command that allows the box to be scaled and stretched.

'G' defines an elastic box as above but limited to the size of one large sprite. The difference is that, when the cursor is moved, the whole section of the screen defined moves along too. In other words, the sprite becomes the cursor. This made me feel extremely seasick and is not recommended after a drink (or anything else). Pressing 'O' makes the sprite's background transparent so that, rather than moving around a square sprite, it becomes the shape of the object you picked up. Each time you press the fire button the sprite is copied onto the bit-mapped screen leaving a full colour 'potato print' in the corresponding position. Keeping the fire button held down and moving the joystick sweeps the sprite along leaving behind a trail of prints. This looks as if someone has covered a small furry dog with coloured paint and dragged him around the screen. The joystick action is still fast, smooth and sweet. Picking up an elastic line with the sprite-cursor and pressing 'L' again causes the sprite to be swept along the line. The effect you get from sweeping the sprite around an elastic circle has to be seen to be believed! The sprite can be mirrored and inverted. These effects are most imediately accessible if a previously created scene is edited. After five minutes you will think you're Picasso, Max Ernst and Salvador Dali all rolled into one.

For detailed editing, pressing the space bar magnifies the screen by a factor of eight. You look through a window which can be scrolled, using the joystick or keys, over the whole screen. Drawing, including elastic lines and circles, etc, (but not sprites) is carried out as normal. Pressing the space bar again returns you to normal. The whole screen can be 'slid' in any direction at the touch of a key (well, three).

A further menu screen is provided allowing you to globally change the screen colours, define textures and so on. A disk catalog and screen save/load is provided, but there's no form of data compression to speed things up. Paint Wizard is supplied on disk only, smartly packaged in an A5 sized cardboard box (which still bears the logo 'Paint Magic'), with a good manual.

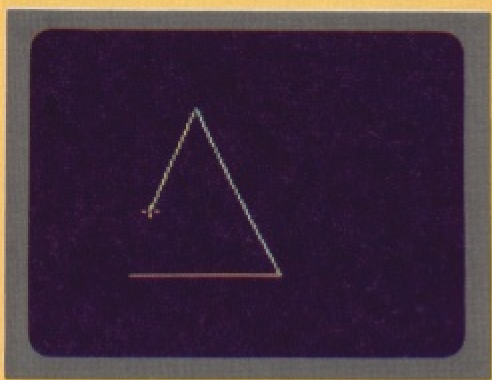
●Peripheral Vision

The Edumate light pen is described elsewhere in this issue. Peripheral Vision is an optional disk based package that can be used with it. At £60, including the light pen, it is a bit on the expensive side, but the light pen is great.

The package is menu driven (nay — icon driven) from the light pen, but you have to keep one hand on the keyboard all the time to trigger the pen! The drawing action is smooth and reasonably accurate (there's a full scrolling zoom, like the Paint Wizard, for editing).

One multicolour screen is provided, without joystick or cursor control. Points, lines, boxes and circles can be drawn in any of four paintbrush colours but there's no elastic banding facility. The philosophy behind the fill and move routines is very unconventional and quite heuristic. A shape is defined by turning the appropriate option on (by pointing the pen at the corresponding icon at the bottom of the screen) and pointing the light pen at it. A cross will then whizz around the border of the object. If the object is correctly defined the command can be continued. The object can be moved by pointing the pen at another part of the screen.

You can change the paintbrush width, and texture fill and drawing in textures are allowed. You can also mirror the screen



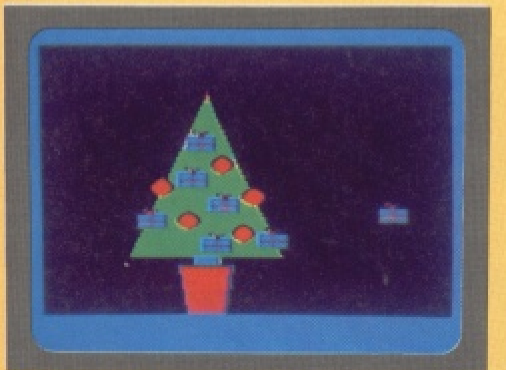
The Draw command is simple enough. Just use a joystick to move the cross-hair cursor around.



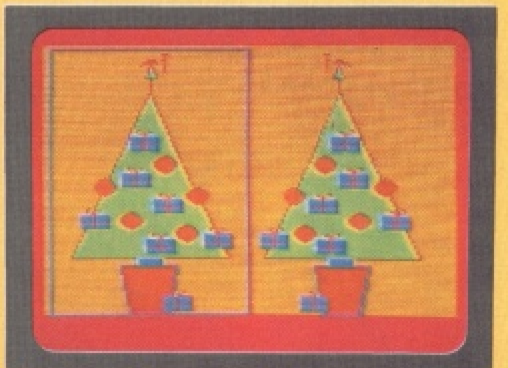
A quick Diagonal fill (*very* quick) and the picture is starting to look suspiciously seasonal.



The Circle command is used to create a ball, and Image is used to define it ready for copying.



The present is repeatedly Image-copied onto the tree in the same way as the balls.



The whole tree is copied, creating a mirror image.

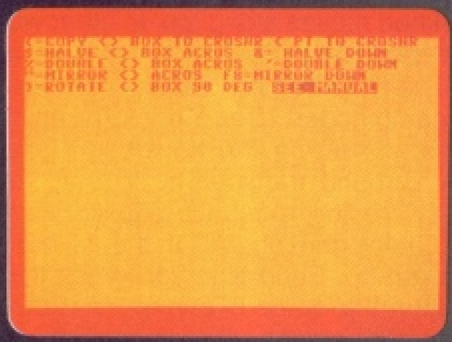


Finally the mirror image is transposed so that it is identical to the original.

COMPARISON OF FACILITIES

	Paint-Wizard	Peripheral Vision	Panorama(H)	Paintpic	Pictograph
GENERAL					
Multicolour	●	●		●	●
Colour mask	●		●	●	
High Resolution			●		
Colour schemes	●		●		●
Light pen		●			
Joystick	●		●	●	●
Cursor keys	●		●	●	
Sample pics	10	1	1	1	5
No. of screens	2	1	1	1	1
Catalog	●				●
Save/load	●	●	●	●	●
Printer dump		●			●
HELP/menu	●	●		●	●
DRAWING					
Points	●	●	●	●	●
Lines	●	●	●	●	●
Rays	●				
Elastic band	●●●		•		
Boxes	●	●		●	
Circles	●	●	●	●	●
Elastic circles	●				
Ellipses			●	●	
Fill	●●●	•	•	•	●●●
Merge	●				
Texture fill	●	●	●		
Texture draw		●	●		
Define texture	●	●	●	●	
Brush width		●		●	●
Text				●	●
Perspective				●	
Cancel	●	●			
Stop key	●		●		●
EDITING					
Zoom/scroll	●●●	●●●	•		
Copy block	●●●	•	•	•	
Mirror copy	●		●	●	●
Move block	●●●	●●	•		
Drag block	●●●		•		•
Sweep block	●●●			•	
Transparent	●				●
Scale copy	●			●	
Slide	●				
Mirror		●		●	
Segment erase			●		
Manual	●●	•	●●	●●	●●
PRICE	£36	£60 +pen	£18 £20	£20	£20
MEDIUM	disk	disk	tape disk	tape	cart
VALUE FOR MONEY	9	5	7	6	7

●Paintpic



A comprehensive menu but could be a lot user-friendlier.



Capable of very impressive pictures, although producing them can get tedious.

●Panorama(H)



The main command menu is well laid out, and most of the commands are easy to remember.



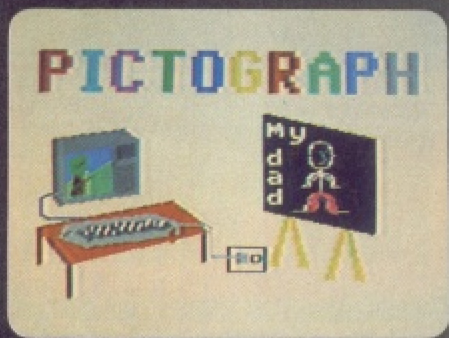
***Panorama (H)* can be slow and noisy (emitting a loud wail when you make a mistake!), but the results can be impressive.**

as you draw to achieve a kaleidoscope effect. Other features include an 'undo' option, which cancels the last command, and a screen-dump to printer. The package comes in a thin A5 cardboard box containing the pen, the disk and an extremely poor instruction manual. For £60, I would find this system disappointing in its lack of facilities.

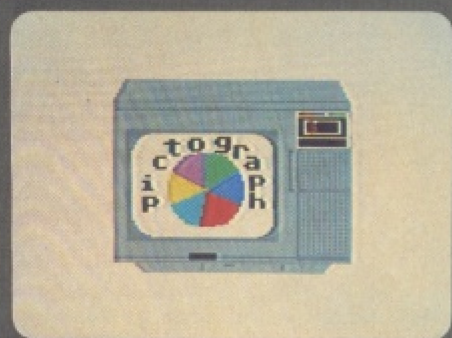
●Panorama(H)

Panorama is the only bit-mapped high-resolution graphic art system I looked at. It's produced and used by Talent at Edinburgh University to create

●Pictograph



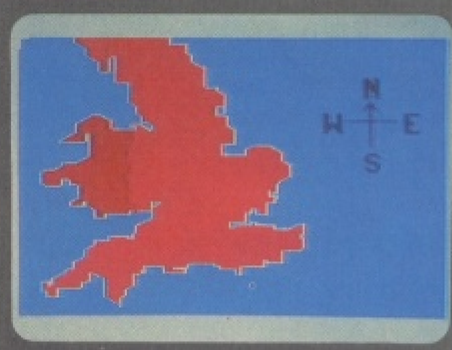
The figure on the blackboard is apparently Daniel Cohen's dad Jack! A figure well-known to ICPUG members.



Somehow the pictograph demo screens aren't quite as effective as the *Paint Wizard* ones!



The fill routine seems identical to that used in *Paint Wizard* — it's fast and efficient.



Saving and loading screens is fast — a highly efficient data-compression technique has obviously been used.

THOUGHTS & CROSSES

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HARDWARE & ADD ONS

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Pro Ace Joystick	£10.00
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DK'Tronics Dual Port Interface	£12.00
Shure Shot Programmable Interface	£22.00
Cambridge Programmable Interface Joystick & Tape	£29.00
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Kempston Centronics Interface S	£ .

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the graphics for its games, and is supplied on cassette with a thick, duplicated A5 manual — with an index! Only one black-and-white demo screen is provided, but this is quite impressive (and rather surrealistic).

Joystick or cursor control is provided. Points, lines, circles and ellipses can be drawn, with crude elastic banding for lines only: the band erases anything it crosses! Sometimes this can be used to good effect, though at worst it's a bug, and at best lazy programming. Lines can be drawn in either foreground or background colour. The action is slow and noisy. If the user makes what the system recognises as a mistake it will emit a wail reminiscent of the day I accidentally flushed the next door neighbour's cat down the loo. The cursor can be moved eight pixels at a time by using the f1 and f3 keys. The cursor is rather large and can obscure part of the picture, so a smaller cursor, like a circular gunsight, is also available. The system is menu-driven, and all commands have two letter mnemonics. The space bar toggles between the picture and the menu.

Texture-fill, draw and define are provided and a special texture editing screen is available. If you select fill, a trial fill is carried out for your approval: you can then accept or reject it. There are crude move, copy, drag, zoom and colour mask facilities, and line segments can be auto-matically erased. A useful segment erase facility is provided. Hit the 'Z' key and move the cursor until it hits any part of a straight line segment and the whole line is erased.

Pictures can be saved to disk as well as cassette. Panorama(H) stores its pictures under the Kernel ROM so that it is necessary to use machine code to access the pictures from your own programs.

The manual covers all the features provided quite well. It is particularly good for its explanation of the use of colour in high resolution mode. Panorama(H) is one of a series of packages from Talent for creating graphic displays on the Commodore 64. These include Panorama(M), for designing pictures in multicolour mode; SPRITE, for designing sprites; and ANIMATE for designing animated sequences. All the programs in the series use a standard form of file storage. Well worth considering.

•Paintpic

This package comes all the way from New Zealand software house Kiwisoft, and is distributed by Kuma. It retails for £20, and is supplied on tape with a thick A5 manual and a crib card. Kuma has some incredibly impressive demonstration screens available. The manual is excellent. Written like a tutorial it takes the user step by step through all the commands, using examples at every stage. Detailed contents pages allow easy reference to any command. Tips are given on photographing the screen, and on using pictures you have created in your own programs. The program takes seven minutes to load and you can then draw points, lines, boxes, ellipses and circles on one multicolour screen under joystick or cursor control. The action is rather slow but you can speed up the process of moving the crosshair around by using the nine home positions spread around the screen.

The fire button toggles drawing mode on and off and the brush width can be changed. A paintbrush mode, with individually definable brushes and bristles which can be saved and restored to the screen, allows large areas of the screen to be painted with textured patterns. Text mode allows the full Commodore character set to be written to the screen and construction lines can be created to a perspective point — a good and original facility. Again I find the package to be badly lacking in facilities, particularly a fill and zoom. I can imagine that it could be very tedious to produce pictures as impressive as the demonstration screens mentioned above, with this package. Nice manual, shame about the software.

•Pictograph

Pictograph was written by Daniel Cohen and was first demonstrated to me at the 1983 Commodore show. Cohen manages to produce this excellent package on cartridge for just under £20. The review copy was supplied with a small (4 page) manual and a disk of demo screens and utilities (normally available separately at cost). The manual is a bit confusing and really needs to be rewritten. Using joystick control only, the action is fast and smooth and reminiscent of Paint Wizard — in fact the fill routine appears identical. I'm sure this isn't plagiarism, it's just that young Daniel knows exactly where his graphics are at. There's even a sprite 'potato-print' option that allows 'drag' effects. Unfortunately the sprite only picks up one foreground colour at once while the background colour is set to transparent.

The screen save/restore commands use a very efficient data compression routine.

It's difficult to say more about this program, especially as so little information is given in the manual. Like the previous three systems it is not exactly brimming with features, but nevertheless achieves its aim. A snip at the price.

Y64 DATACARD

NAME: Paint Wizard	NAME: Peripheral Vision	NAME: Panorama (H)	NAME: Paint Pic	NAME: Pictograph
TYPE OF PROGRAM: Graphic Art	TYPE OF PROGRAM: Graphic Art	TYPE OF PROGRAM: Graphic Art	TYPE OF PROGRAM: Graphic Art	TYPE OF PROGRAM: Graphic Art
MEDIA: Disk	MEDIA: Disk	MEDIA: Tape or disk	MEDIA: Tape	MEDIA: Cartridge
PRICE: £36	PRICE: £36 including light pen	PRICE: £17.95 tape, £19.95 disk	PRICE: £20	PRICE: £20
SUPPLIER: Softsel	SUPPLIER: Edumate	SUPPLIER: Talent	SUPPLIER: Kiwisoft	SUPPLIER: Jack Cohen
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ZAXXON VERSUS HAVOC

Very occasionally a game arrives that everyone agrees is a classic of its kind. Zaxxon is one such. Written firstly as an arcade game, then implemented on the Atari, Synsoft has finally written a version for the 64, and US Gold has brought it to the UK at an affordable price. Coincidentally, or otherwise, Dynavision has simultaneously launched Havoc — a game bearing a strong resemblance to Zaxxon in both scenario and graphic technique.

ZAXXON

1

Your journey begins in space. The space fortress scrolls diagonally in from the right.



2

A high wall, with a notch at the top, is the first barrier. Climbing to maximum altitude and moving to the right will see you safely past this obstable.



Having passed the wall you'll be in the outer defence city of the fortress and be able to see the much-admired graphics. Unlike Havoc, Zaxxon has ground markings and actual structures with height — fuel dumps, gun emplacements, radar towers and enemy planes.



3

There is restriction on fuel, so the first thing to do is to learn how to blast the fuel dumps. To do this you have to get down low and on line. This isn't all that difficult but once you're low you can be hit by the fire from gun emplacements or collide with other objects.

It's also worth shooting the radar towers because if they're left to their own devices they'll try to destroy you with missiles. These come in horizontally and need to be hit three times to blow them up.

5





6

If you die you go back to the start of that particular phase, but once you're familiar with the controls and you're accustomed to the perspective, you'll get to the electric force field. You have to climb over it and then get low again, because on the other side are stationary enemy fighters which are sitting targets. Each kill at this stage means one less in the next phase.

The second phase is set in space and you have to fight off a number of enemy planes. The number left is displayed in the bottom status line. This is an extremely tricky phase as you have to get on target in three dimensions. The best clue is to match the size of your fighter to theirs and fire like mad!

7



There's an automtic targeting device which bleeps and puts a small cross on the screen when you're on target. This phase is time-based first time round, and if you survive long enough you'll approach the Zaxxon robot's fortress.

HAVOC

1

Pressing fire gets you into the game proper and you'll see your small, red delta-wing fighter sitting on the ground. Pull back on the stick for take-off and the ground begins to scroll past.



You look down on the playing area from an angle of about 30 degrees, allowing you to see further ahead than in Zaxxon and giving the impression that you, the player, are watching from further away.



2

Almost immediately a magnetic mine starts to home in on you and if you don't shoot it quickly it'll get you.



4

There's no restriction on the number of missiles you can fire, and in fact you can have four shots in the air at any one time, so your firing power is much greater than in Havoc.



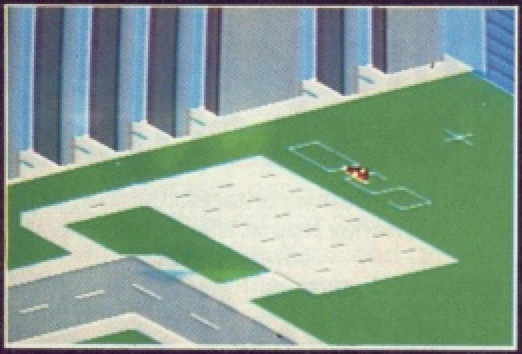
8

This screen is graphically similar to the first but contans more closely spaced walls with only narrow slots, and small force fields drastically reducing their size.



3

The smart bombs drop vertically from above — smart because they kknow where you are and drop right on top of you. Thankfully as they come down they cast a shadow on the ground so you get a chance to avoid them.

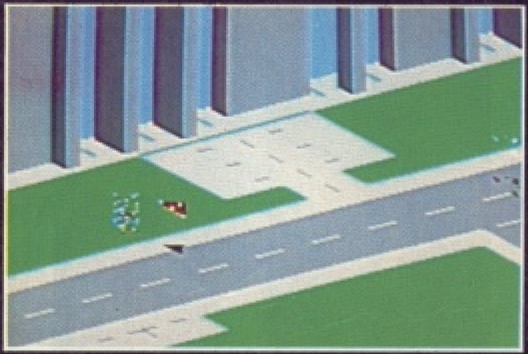


Vertical missiles will also be launched but operate independently from the radar.



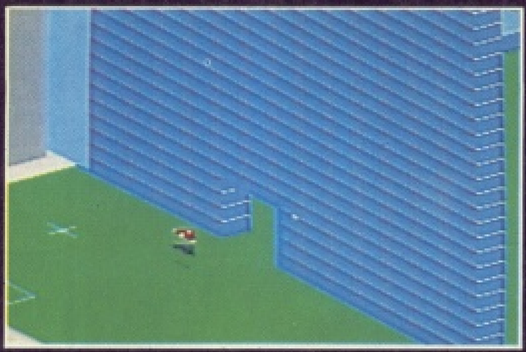
9

It's difficult to hit many fuel dumps and avoid the gun emplacements and get lined up safely to pass through these holes, but you'll have to do it if you're going to meet the robot. The best way I found of doingit was to be low enough to shoot just beneath the hole, checking for left/right alignment and then pulling up until my shots went through safely.



4

Havoc can get very frustrating because your ship doesn't seem to do as you tell it, ignoring your frantic joystick movements. It slowly becomes apparent that as each bomb explodes, no matter how far away, its shock waves blast your ship off course for a second and make control very difficult. If a bomb hits you you're out of control for longer.



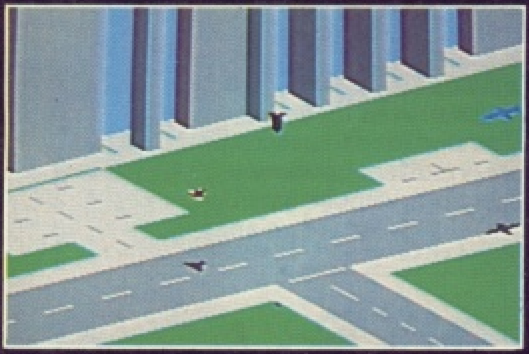
6

At the end of the first stage a wall completely blocks the way ahead except for a small gap which you have to aim for. The best way I found of doing this was to line up with the left hand edge of the last road and just stay at the right height.



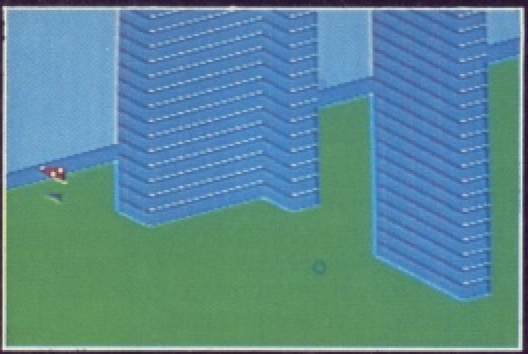
10

Having dodged through, the scrolling will cease and you'll find yourself facing a grid and the Zaxxon robot. He/she/it will advance towards you and needs three shots in its missile launcher before it'll retreat. If you reach the second sheet for the second time you have to shoot all the enemy fighters before being allowed to progress further.



5

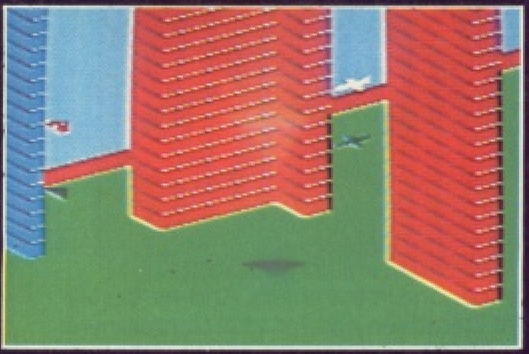
Trying to shoot down a missile is tricky, but once you realise they come in at two points and at the same height you can begin to position the fighter to give the best chance of shooting them. Watching the shadows on the ground is usually the best way of lining up on a target.



7

Once through, a whole new world of towering pillars opens up before you. It's next to impossible to dodge through the pillars and soon you find that travelling along the left hand edge is the safest place to be. Many missiles travel along this route. If you don't blast at least two missiles you'll run out of energy and grind to a halt.

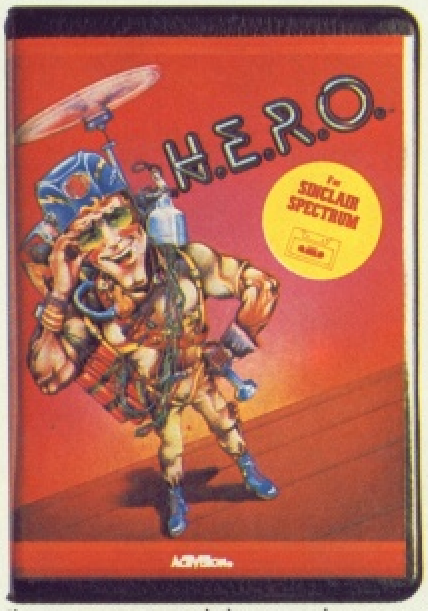
8



The Activision Eight.



Pitfall Harry has to recover the priceless Raj Diamond from the lost caverns. But there is a small matter of poisonous frogs. Albino Scorpions. Vampire Bats. Electric Eels. Need we go on?
Running on Commodore 64, MSX, and Spectrum



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Running on Commodore 64, Spectrum, MSX



And you thought it was just a movie. But Ghostbusters is a computer game, too. Following the film with incredible accuracy. Even down to the chart topping music score.
Running on Commodore 64 and Spectrum. Soon on other systems.



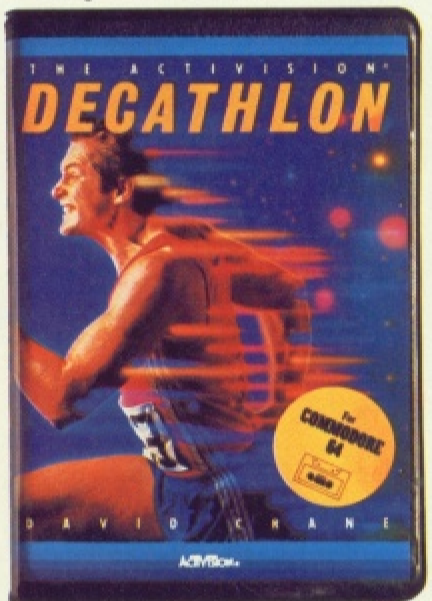
With the Designers Pencil, you can draw the world – and everything that's in it. Write your own melodies. Learn to write and develope your own programs. Its scope is as broad as your own mind.
Running on Commodore 64 and Spectrum



Man's ultimate journey. You can make it, in faithful detail, from lift-off, through an outer-space rendezvous, to landing. A genuine test of your inner strength.
Available soon for Commodore 64 and Spectrum



Stay cool. Stay low. Stay alive. Your mission is to fly down the world's most heavily defended river, destroying everything the enemy hurls at you. But beware... your fuel tanks are nearly dry.
Running on Commodore 64, Spectrum, MSX



Number one in the charts. And set to stay there. Decathlon asks for total commitment. Speed. Strength. Stamina. The will to win.
Running on Commodore 64



Merton the maintenance man is set for yet another routine night in charge of the toy factory. But something has gone terribly, terribly wrong.
Running on Commodore 64. Soon on Spectrum

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ZAXXON VERSUS HAVOC

Both games have achieved an extremely effective three dimensional feel. The player looks down on an area of ground which appears to slope up from left to right. You look down on your fighter with its shadow on the ground below and can bank it, climb and dive. This ability to move around in an area of 3D space makes these games unique and gives them much of their appeal. The diagonally scrolling playing area and resulting graphics are very impressive on both games, although Zaxxon has a repetitive playing area which gets more difficult, while Havoc has a very large changing playing area. The idea in both, however, is to penetrate an enemy stronghold and destroy the anti-social villains, saving civilisation as we know it today (what else?). So strap yourself in and prepare to fly into the unknown.

HAVOC Dynavision

The absence of adequate instructions make Havoc very confusing when you first begin playing. Briefly, an enemy is launching an attack on the now peaceful civilisations of the world and, as a member of the World Peace Force, you have to fly through enemy territory under constant attack to destroy a missile launch site; a task that even the best pilots will find annoyingly difficult.

Before you start, your friendly base computer, hidden away in a very safe bunker somewhere, will inform you of your mission and gives a few hints on what may happen. This computer can be accessed at any time simply by landing — a useful strategy if only because it gives you a chance to take a breather. You have 100 points of energy which decreases each time you fire — zero means the game's up. The nasties to shoot or avoid are magnetic mines, smart bombs and cruise missiles, each of which have to be dealt with in different ways. If something hits you, your ship's navigation sytems will be temporarily impaired, and for each cruise missile that passes you, 10 per cent of your homeland will be destroyed.

The first two screens are confusing to say the least, and the following ones seem to be just variations of these, but with trickier combinations of horizontal gaps and vertical pillars and other minor differences.

ZAXXON Synsoft

Zaxxon is a highly-rated convert originally from the arcades and later from the Atari in which the player has to penetrate the Zaxxon's space fortress with the eventual aim of destroying the zaxxon robot. Ample instructions explain each stage of the game together with scoring system.

After an entertaining Novaload (to the accompaniment of the Star Spangled Banner!) you can begin play. The first difference you notice between Zaxxon and Havoc is the two status lines at the bottom of the screen. These display the number of remaining lives, fuel, score and the number of enemy planes left to be shot. You have five ships and you'll need to keep the fuel level up by shooting fuel dumps (a somewhat contorted logic, but it seems to work). You control your fighter in the same way as in Havoc, although it's a lot easier to judge your altitude, as the ship changes size according to its distance from you, and of course the altimeter helps.

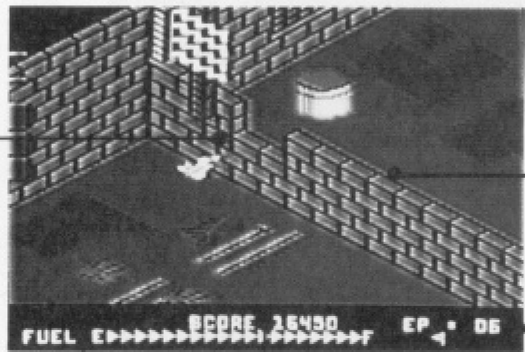
At first there are plenty of distractions and challenges, but they're all packed into a mere three sheets, which does seem rather few to maintain interest and I've heard it said that Zaxxon is too easy. It may be true that destroying the robot for the first time doesn't take too much practice but reaching those really high scores will take a lot more effort.

Conclusion

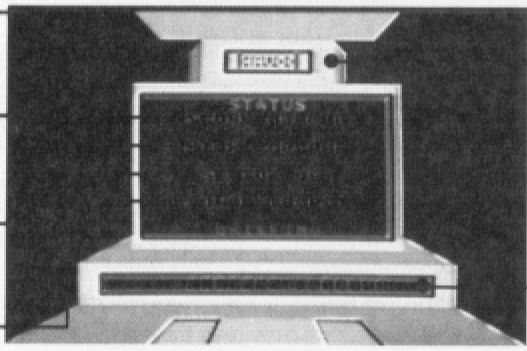
Both games will probably appeal to the same kinds of players, and because they offer a similar scenario are in direct competition. The graphics in both are 'excellent, but Zaxxon must win here because of its extra ground features. Sound-wise there's little to choose; I find both are nothing very special, although Havoc's are possibly the better of the two. In play, Zaxxon definitely wins: Havoc is difficult to play, but for the wrong reasons, while Zaxxon has more variation and allows for more skill and strategy.

Zaxxon comes out top then, but I still think it could be considered too repetitious for the current trend of games players.

ZAXXON CURRENT STATUS SCREEN



HAVOC START-UP SCREEN



Y64 DATACARD

NAME: ZAXXON

SUPPLIER: U.S. Gold

PRICE: £9.95

TYPE OF GAME: 3D ARCADE

MEDIA: CASSETTE

REVIEW COPY OBTAINED FROM: SYNSOFT

Y64 DATACARD

NAME: HAVOC

SUPPLIER: DYNAVISION

PRICE: £9.95

TYPE OF GAME: 3D ARCADE

MEDIA: CASSETTE

REVIEW COPY OBTAINED FROM: DYNAVISION

ACTION REPLAY

No. of players · Second player option · Joystick · Joystick optional · Cassette · Disk

PSYTRON
Beyond Software/£7.95

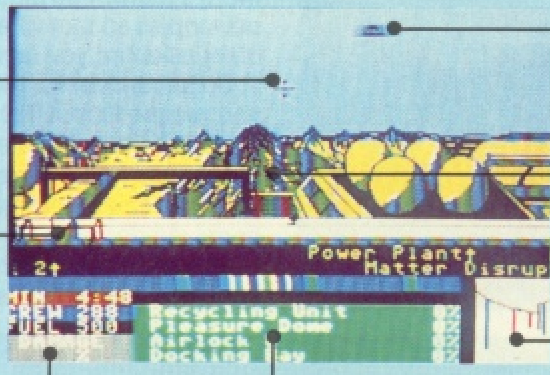
Every year or so someone, God bless 'em, actually comes up with a game that's exciting and original. One that you know is going to have people talking about it for months. Well my vote goes to Psytron.

The Psytron is half human, half computer and controls a space colony on far off Betula 5. The Psytron must know every inch of the complex installation and defend it from attacking alien saucers and the three legged saboteurs they beam down.

To assist in stopping the saboteurs the Psytron controls a droid. The player can see through the eyes of the droid as it chases and destroys said saboteurs. Whilst shooting the saucers down the player must decide which parts of the station he or she can sacrifice to save other more important parts.

The graphics in the game are a delight to behold. By means of joystick or keyboard, the player can scan the base through 360 degrees, receiving damage reports of the various parts of the installation as they come into view.

At each level of the game a new facet of the Psytron's impressive armoury is introduced to the player. All this leads up to the final fifth level in which all of the facets



of the Psytron are put at the player's disposal in a last all out battle.

During the game, the constant attacks by the saucers will inevitably result in damage to the colony's installations. Now, the player must choose which areas of the station are to be abandoned in order to save the rest. These calculations take place during Freezetime, which means the player can halt the action to consider which course of action to take.

Despite the reduced efficiency of the colony, repair teams must be organised. With more humans being despatched to work, this will affect the oxygen and food supplies. All must be considered by the Psytron. Stirring stuff eh?

Let's put it this way. This game is already considered something of a classic and I confidently predict that over the next year or so we can expect a hundred or so copycat games to appear in the shops.

STRONTIUM DOG
Quicksilva/£7.95



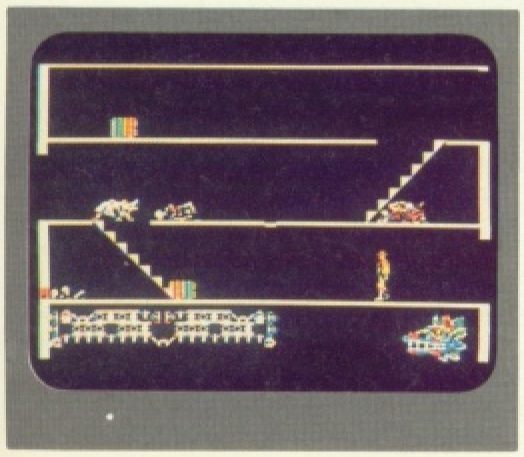
At the moment, the fashion in games software is to base it around a well known fictional character. This game, then, is based on the hero from the comic 2000 AD, Johnny Alpha, known as the Strontium Dog.

Johnny has been dumped on an alien planet which he has to cross to meet his two buddies, Wulf and Gronk. There are of course the predictable criminal nasties, (some of which look suspiciously like daleks) to be blasted out of the way.

To aid him in his quest Johnny is provided with a blaster, electro-flares to dazzle the opposition and Time Bombs which are literally that — they send you back a period of time so the player can start again!

Moving too fast along the terrain saps your strength, so the player is forced to make a casual stroll towards the city where Wulf and Gronk are waiting. What's worse, once you get there, the next level is the same as the first, which I found very disappointing. The graphics are fairly pleasant in a cubist sort of way but get fairly boring after a few games. Quicksilva could have done with some of the imagination of the comic strip when writing this game. Strictly for Strontium Dog fans.

AZTEC
Beyond/£8.95



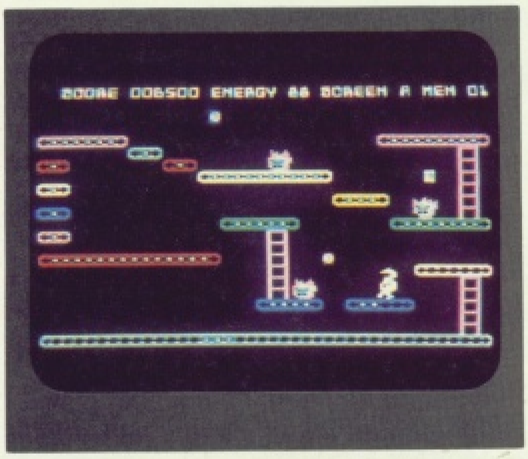
Aztec is a realtime adventure game in which the central character looks suspiciously like one Indiana Jones. The object of the game is to find the Golden Idol, hidden somewhere in an ancient Aztec cave, while avoiding being killed by the various tribesmen, dinosaurs, and other beasties which inhabit the cave.

After entering the cave via some stairs, you find yourself in one of those layered mazes we all know so well. Weapons are acquired by searching the various boxes dotted around the tunnels. Quite what the Aztecs were doing leaving pistols and dynamite around in old wickerwork baskets is beyond me but I'm sure there's a reason for it. The main character and his various adversaries are produced in very fine detail which adds some life to the game.

It's controlled from the keyboard and there are 21 keystrokes which can be used as commands. This presents a bit of a problem. It means you have to be a fairly good touch typist when fending off attacks from the likes of the giant spiders otherwise you end up flat on your back.

This however is a minor beef. Providing you can master the keys, the game is absorbing and should at least keep Indiana Jones buffs happy until the next movie

MR ROBOT
Beyond Software/£8.95



Mr Robot is one of those games where you climb up and down ladders, travel along treadmills and try to avoid the meanies along the way. Sounds familiar? Wait, there's more. You also pick up energising power pills so that when you encounter one of the alienfire you destroy it.

So far, so familiar. Mr Robot also allows you, via the Robot Factory, to create your own screens out of the various bits and pieces you find in the other screens, so that you can "challenge your friends", it says here.

Nothing particularly original in that either you may say. However, I must say I rather liked Mr Robot.

The early screens are fairly boring and you've probably seen the same sort of thing dozens of times before. However some of the later ones are quite fiendishly constructed. I particularly liked the one where you have to climb to the top of the grid to bounce off a trampoline at the bottom to get at the alienfire.

As I say, nothing particularly original in this game but it's unpretentious and quite fun.

STAR TRADER
Bug Byte/£7.95



In the far distant future, life is still not easy for the small businessman. There you are trying to make a crust and you end up spending your time hanging around for the shops to open, paying taxes to marauding pirates and being nicked by dodgy customs officers. Ah, life must have been so easy being a trader in the good old days of the twentieth century.

Star Trader is another of those games that attempts to merge an adventure type strategy game with an arcade style shoot out.

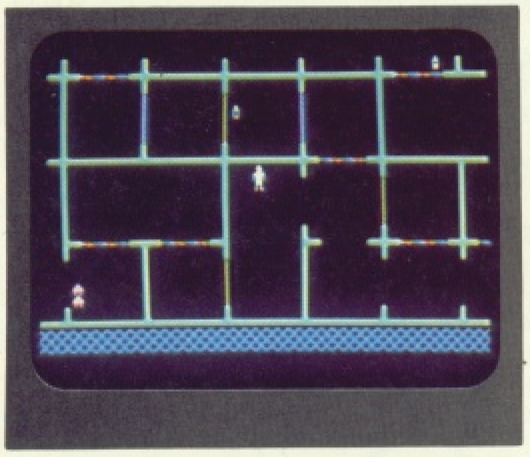
Being the last of the Star Traders plying your wares among the various planets might sound like a nice little earner. But, as you might expect, things ain't quite that simple. There are lots of beings out there who want to get their hands, paws, tentacles or whatever on a piece of the action.

The chief culprits are the pirates who demand a twenty five percent cut of whatever's going.

It's not easy to shake them off and the more fainthearted trader may find it easier to make a deal.

This is a great little game which should keep budding intergalactic capitalists happy for hours. Recommended.

HALL OF THINGS
Design Design/£8.50



Picture if you will the scene in your local software house:
Eager young programmer: "I've got this new game."
Jaded software assesser: "Oh yeah, what's it got in it?"
"Things!"
"Do you mean they aren't called mutant aliens from Mars or anything?"
"Just . . . Things"

These boys have brought a deal of enthusiasm to their task and they have come up with a wicked little game. There you are moving about from room to room picking up the odd bit of treasure here and there. The rooms are laid out on the screen in a grid pattern. In the adjoining rooms, the things (small, coloured blobs) potter about, minding their own business — no trouble you think. Then suddenly, the door opens and the Thing lets loose a hail of lightning bolts which bounce around the room and if you're not quick off the mark, you very quickly find yourself very dead.

Design Design may not yet have created their masterpiece, but Hall of the Things is a nice game and well worth trying.

MAGIC MICRO MISSION
Quicksilva/£7.95

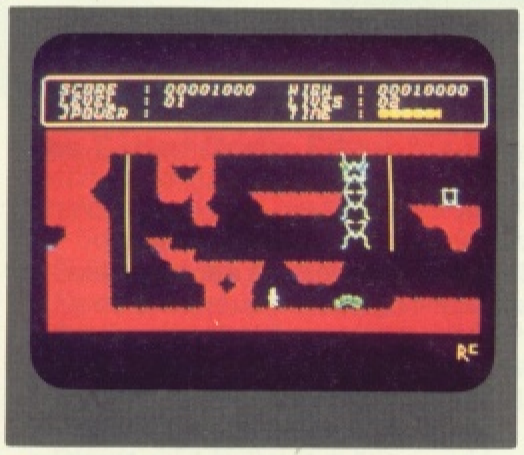


Computer games become incestuous! Divided into two parts, the object of the exercise is to fight your way through attacking waves of robot ships and then land your craft to enter a maze (Quicksilva would have us believe it's the circuit diagram of a computer). You must then locate the Reado Rom chip, whilst avoiding hostile resistors and Ram chips. I know the feeling. In the first part of the game the robots progress in a column down the screen and, by positioning the joystick in the appropriate position, you can give your wrist a rest and just blast the ships as they go through the cross hairs.

In the second level the chips progress around the maze looking like so many foreshortened caterpillars. They don't attempt to try closing in on you, although there are enough of them to make life difficult all the same.

I know it's getting late and I'm probably feeling bit jaded but this is yet another game from Quicksilva where I find myself wondering why they bothered. The game is based around a TV programme of the same name, and I suppose Quicksilva hope that all the viewers will rush out and buy it. That, however, is no reason why anybody else should.

CAVE FIGHTER
Bubble Bus/£6.99

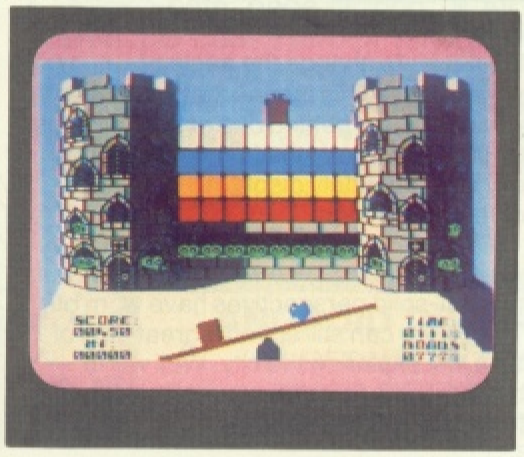


Cave Fighter is a game where you explore underground caverns by swinging around on ropes disposing of pterodactyls, giant caterpillars and lunar robots(!) — a sort of troglodyte Tarzan.

You start the game stuck at the bottom of a pit. Above you is a rope which you have to shin up to the first level. From here on, things start to get difficult. It's not so much the creatures of the caves that you have to worry about — they can be quickly zapped with your laser or whatever it is you're supposed to be carrying. The problem is negotiating the obstacles that get in your way. For some reason best known to the programmers, running into the old terra firma kills you just as easily as the pods of the killer flowers.

At the end of each cavern you are taken to the next cavern which is a slightly more difficult variation of the previous cave. This helps in as much as you know vaguely what's coming, but it does get depressing starting off in the same old pit. The graphics and sound are OK but nothing to write home about. Cave Fighter is a bit like a cave, gloomy and smells a bit musty. For swingers only.

SEE SAW
Quicksilva/£7.95



Your're stuck outside this castle see, standing on the see-saw. Now hold on, let me finish. This evil magician is throwing bits of the wall down on top of you, and the idea is that you stand on one end of the see-saw and, when one of these rocks lands on the other end, you are catapulted over the castle walls to effect a rescue. Trouble is, unless you want to be thrown into mid air you've got to juggle the rocks around on the see-saw to get the right balance.

Oh, I nearly forgot, the magician has these henchmen, looking remarkably like ET, who are supposed to catch people who bounce off see-saws.

Now be honest, does that sound reasonable to you?

I know we're coming up to the Christmas period and the software houses can usually expect to shift every program they can produce, but See-saw really is dumb. God knows how much expensive computer time and how many even more expensive programmers were spent working on a game that is basically soppy.

Quicksilva is quite on the level about the title: See-saw really is a let-down.

TERRORIST
Virgin/£7.95



Are you a vicious malcontent harbouring a grudge against society? Do you think you're tough? Able to handle a gun? Then there's a job for you in anti-terrorist squad. Your first mission is to play this game and serves you damn well right too.

Terrorist, from the home of tasteful software, Virgin, is an extremely silly game. It starts by displaying a map which is then blanked out. You have to remember it to be able to manoeuvre your patrol car and boat around. The trouble is, the maps I was shown bore no relation to the map actually in the game! This meant I ended up getting to the scene of the terrorist incident (shown by a bomb going off — so charming) by helicopter gunship.

The rules say that you must get to the incident as quickly as possible. But whenever you get there the program leaves you hanging about before showing you the scene. You then have to blast the terrorists as they appear otherwise they off your men.

I remember when Virgin used to be run by hippies. I wish they'd go back to their communes and not keep bothering us with shoddy games that they think will appeal to "the kids".

AD INFINITUM
Mr. Chip/£7.50



Galaxians lives! This is another game from one of the smaller software houses which could perhaps teach the bigger boys a thing or two about what an arcade game should be.

Ad Infinitum is basically one of your run-of-the-mill blast-the-invader type games. Without the fancy backgrounds and whizz-bang sounds it manages to keep the player's interest longer than five minutes.

The blurb on the insert claims that there are 256 different screens. What I see is one screen and 256 different (though I haven't actually counted them) waves of invaders. The invaders are sprite-sized beasts, so are fairly easy to hit. I liked the wittiness with which the sprites have been designed. Mind you, some of the ease of potting them is taken away, because if you overuse the fire button your ship blows up (*this* is user-friendly??). So people whose tactics in such games is keep the fire permanently down will have trouble.

I sometimes wonder whether we are being observed by beings from another planet. God knows what they make of the glee with which so many earthlings spend their time zapping aliens. It's no wonder they haven't made contact.

ADMIRAL GRAF SPEE
Temptation/£6.95



Ah, a life on zer ocean wave! You are Kaptain of the Graf Spee, German pocket battleship and all-round playground bully of the Atlantic. Your orders from the Fuehrer are to sink all the enemy shipping you can lay your torpedoes on, and generally pile up indictments for your trial at Nuremburg.

You start by trying to catch one of the blips on the screen, representing allied shipping, which appear and then disappear with irritating frequency. Once you've actually caught one of the ships, switch to search mode and the view changes to the bridge with the ship on the horizon. Provided that you can keep the ship in sight, the idea is to attack it with either guns or torpedoes. This is where the trouble starts.

I've played this game on the Amstrad, and very good it was too. In this version, the keyboard response was diabolical.

This meant that chasing a fast moving vessel, was, to say the least, difficult. Trying to outmanoeuvre a ship that was actually firing back at you — Well, mein Kapitain, shall we scuttle now or wait to be sunk?

A good game badly implemented.

ANT ATTACK
Quicksilva/£8.95



Over the past year or so, you may have seen small groups of Spectrum owners gathered together and speaking in hushed tones of Sandy White and Ant Attack. Well, now Commodore owners can at last discover what all the fuss was about.

Ant Attack is set in the city of Antescher, and your task is to search the city in order to find and free your captive partner. Once you've freed him/her you both have to make it back to the exit. Antescher is occupied by hordes of marauding giant ants whose main pastime is to attempt to make a meal of you.

The great thing about Ant Attack (which is what all the fuss is about) is the ability of the player to change the angle of perspective. This means that whenever you disappear behind one of the buildings by pressing one of the function keys, the city is immediately displayed from a different direction.

This game is a classic and remains an absorbing game even when the novelty of the soft-solid perspectives have worn off. The player can still spend a great deal of time just exploring the city. Well worth buying if only to spare yourself pitying looks from Spectrum owners.

KIKSTART
Mr. Chip/£7.50

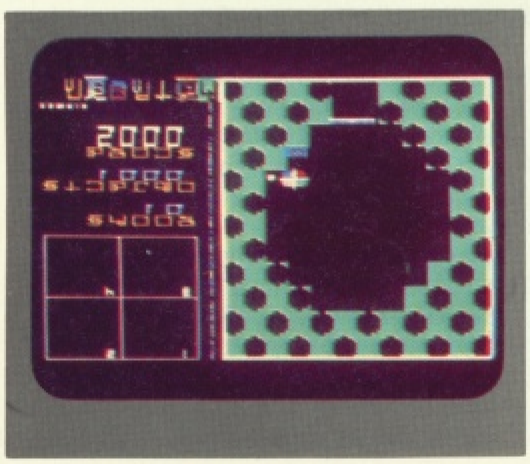


No, Kikstart is not an auto-boot program, (sorry about that). It's a game where you have to manoeuvre your trial bike over gateposts, cars, buses, tanks of water and lots of other things that I'm not normally faced with on the North Circular.

It's been a long time since I drove my scooter down to Brighton, but Kikstart is about as realistic as you can make it sitting in the comfort of your bedroom with a joystick. I'm not saying that you can smell the oil and feel the bruises, but you can accelerate, decelerate, perform wheelies and jump just like they do on the telly. There are time penalties (which consist of you lying in the mud for five seconds after going over the handlebars for the Nth time, wondering whether you should have opened the throttle just that bit more).

The insert warns that this is a game that takes a while to master and I can well believe it. I spent more of my time eating mud than riding the bike. The graphics are good and it would seem just the game to while away the hours while you save up for that 250 cc Kamikazi you've set your heart on. In fact get your parents to buy you this one. They would be far happier in the knowledge that Junior is careeering about a screen rather than the streets.

ANKH
Beyond/£8.95



Ankh is a weird little game where you wander around rooms of various shapes and sizes seeking some treasure or other. The rooms themselves have a surreal quality with certain rooms containing strange goings on that for some reason reminded me of a Franz Kafka novel.

Actually, what it reminded me of most is a journey through someone's intestines, so perhaps this may not be the ideal game after a heavy meal.

On your travels through the rooms you encounter the guardians, which reduce your energy as will contact with any of the walls of the rooms. There are also portals to be opened: the doors can be unlocked either by firing at the relevant lock or by investigating the lock with your mind probe — which looked rather like some sort of proboscis (back to intestines again).

The game requires a certain exercise of logic, and all in all was an absorbing way to spend an hour or so. Unfortunately, there seems to be only one layout so that once you've solved the various brain teasers, there doesn't seem to be much else to do with the game except re-use the tape for something else.

SORCERY
Virgin/£7.95

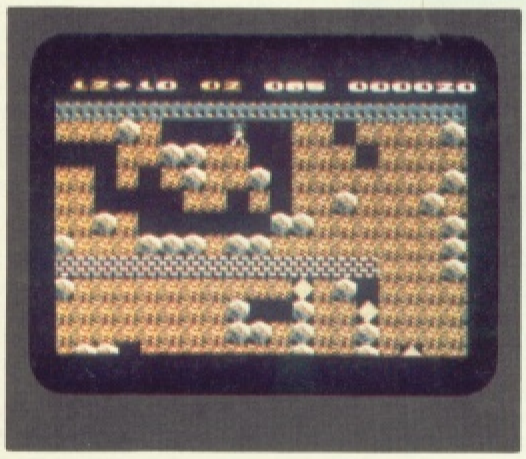


It seems that Virgin have taken to heart what I said about them being better off as hippies. I shall allow the Virgin spokesperson to explain. "This game is about Sorcerers and Stonehenge, Man, and the eternal struggle between the forces of Good and Evil and, like, the graphics in this one are really far out with you as the sorcerer having to avoid ghosts and ghoulies in this strange land of castles and forests.

Every so often, Man, your energy, you know, the cosmic force, starts running low and you have to replenish it. I'm not allowed to tell you how it's done, like it's a cosmic secret and it would be bad Karma if I told you. Anyway, there's 17 screens to pass through, but to get through the door to like a higher level of conciousness, you have to be carrying the right sword or spell. But all the time you've got to hurry,'cos like at the bottom you can see Stonehenge crumbling away before your eyes. Heavy.

This is a far out game and if you all went out and bought it Virgin might stop producing cruddy games like Terrorist." Thank you. I have nothing further to add.

BOULDERDASH
Statesoft/£8.95



You thought Willy was the Manic Miner? I'd like to introduce you to his American cousin, Rockford. Rockford is a bug eyed little creature that looks a bit like ET in pyjamas and what he does is dig around the earth looking for diamonds.

He's a strange character is Rockford. While he's not digging he's standing around tapping his feet at you. He can quite happily stand with a boulder on his head but if one falls on top of him that's the end of Rockford.

At the lower level Rockford can push boulders out of the way, but he can't at the higher levels. All of which Rockford can turn for a profit. By dropping boulders onto butterflies he turns them into more precious jewels that he can collect. But life isn't all fun and games for Rockford. He must avoid the fireflies though, otherwise it could bring an end to his career. As with most American software that seems to find its way over here, this game is well designed and well written, the graphics being of a high standard, though there's not much scope for graphics in a boulder mine. Pleasant enough but not rivetting.

PACMANIA
Mr. Chip/£9.99



I bet you'll never guess what this game is about. Aww, you must have peeked. There's this little man in a maze being chased by these ghosts and . . . oh fill in the rest yourselves.

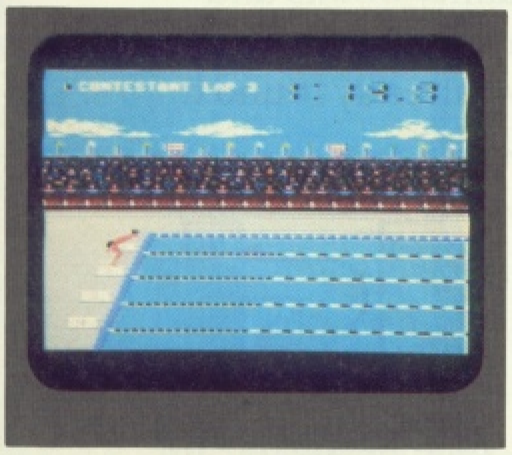
Mr Chip informs us that the reason it (he?) has seen fit to bore us all with yet another version of the demon gobbler is that this version also has hyper-maze ports which can transport you from one part of the maze to another. I say the only reason for that is to prevent Atari suing the company and doing us all a favour.

The only possible explanation why Mr Chip, in its infinitesimal wisdom, can have decided to inflict this on us is that every other software house has a version of Pacman so why should Mr Chip be the odd one out?

As a matter of interest to anyone out there who might be tempted to buy this nonsense, the much vaunted Hyper-maze transporter is of no use in the game and is more trouble than it's worth. It only ever sends you to somewhere you don't want to be.

They say that every Christmas brings a turkey but this one from Mr Chip won't be on my table this Yule.

SUMMER GAMES
Quicksilva/£14.95



For those of you who still haven't had enough of the Olympic games, there is yet another game out especially for you. Not only can you watch all that physical exertion from the comfort of your own home, you can actually influence the course of the race. Breaks you into a sweat just thinking about it.

I must confess I get a perverse sort of pleasure sitting in a comfy chair smoking a fag and drinking a beer, while my thumb idly taps the fire button of a joystick so that my swimmer can get that extra bit of power in the stroke. It's hard work being an athlete.

As you probably know by now there've been more packages of this sort released this year than there are competitors in the London Marathon. Summer Games is actually one of the better programs available. The graphics are uniformly excellent and the eight games themselves are well designed. These range from High Diving to Skeet Shooting. (That's clay pigeon shooting to you and me).

If this sort of thing is for you, your best bet is to see what the choice of events is and choose which form of armchair torture best appeals to you.

FIRST AID



for your 64

Computers, like people, are fallible. They need the right combination of code and care to perform effectively in the business or the home. And that requires first hand knowledge from you to create a healthy operating environment for your Commodore 64.

Knowledge about machine language, about the lesser known qualities of the 64, about the disc drives, graphics, and about the tricks and tips to keep your 64 on line. That's why First Publishing has now launched in the UK a series of high quality books and software packages to provide a complete health care kit for your 64. Commodore 64 users throughout Europe have already found it a tonic. We think you will, too.

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■ All the best to the most recent pupils of 3L, Latymer Upper School. A special hallo to Mum, Dad and Nataly. Alen.

PILOT

Pilot is a much under-rated language in the UK, and one that has more going for it than just its better known role as a tool of educational computing; it's both flexible and easy to use. Dave Janda *presents a summary of the 64 implementation.*

L.A.N.G.U.A.G.E LAB

Pilot is an interpretive, computer-assisted instructional language designed for interaction with the user. Its major applications are to be found in the educational field — the area for which it was originally and specifically designed. Pilot is particularly suited to the 'question and answer' type of program, because the features within the language make for powerful answer processing. In most popular languages, this facility is both clinical and restricted. However, Pilot allows a degree of 'give and take'; wrong spelling, for instance, may still be accepted. Decisions that depend on the answer given are also easy to take. Half marks may well call for a different course of action than the proverbial 'ten out of ten', and Pilot handles this very easily.

But before starting on the pros and cons of the language, first a word to those programmers who are *not* interested in the educational field: Pilot is a perfectly good programming language in its own right ... that is, it can be used for other applications besides the obvious educational ones. You'll find, for instance, that its graphic capabilities make the crude POKEing in Commodore Basic look rather stupid. Add the fact that the control structures are very flexible, and there you have two good reasons why all hackers should read on.

Sound and graphics on the 64 are never that easy to program and control, but Pilot offers many commands that facilitate their use: windowing, for example, where the screen can be divided into a number of sections. Here the top half can be used for the question and answer input, the bottom for program response, and so on.

Structural Survey

One of the biggest advantages of Pilot is the simple layout. Forget line numbers (and GOTOs, for that matter); a Pilot program is made up of 20 single-letter op-codes (operation codes) — see box.

These instructions can be optionally followed by modifiers that change some aspect of the instruction. For instance, the use of the 'T' (TYPE) instruction can be followed by the 'H' or 'S' modifiers; 'T' alone simply prints text or whatever to the screen, but if it's followed by the modifier 'H', no line feed will occur after printing. On the other hand, followed by the 'S' modifier, the screen window (normally the whole screen) will be cleared before any printing takes place.

After the modifier comes the optional conditioner, which is written in brackets. This is similar to the IF...THEN... construct that's found in all dialects of Basic. With Pilot, the conditioner must return a true value before the instruction can be performed. A conditioner could be '(A=B)', which simply means that A must equal B if the instruction preceding the conditioner is to be executed.

The remainder of a Pilot instruction follows the colon which must always be present, even if there's nothing to come after it. What follows can be text to be printed, numbers, variables, or any mixture thereof. This area is called the field, and it also contains sub-commands — for example, instruction 'G'. You can follow this with one or more graphic commands, each separated off by a semi-colon; if the commands need any arguments, these are separated by commas. Take a look at our 'Pilot at the Controls' box, and you'll see two areas of demonstration.

By now some readers will have realised that the instruction layout in a Pilot program is very similar to that of assembly language and the problem with this type of setup is that reading a Pilot listing involves translating the op-codes into the full instruction. It would have been a simple matter to extend 'T' to TEXT and this would have made the language self-documenting. As it is, the commands show a low level syntax for a high level language!

Pilot Expressions

Pilot allows up to 26 variables to be used in a program. Unfortunately, these can only consist of single letters in the range A-Z, which is rather limiting. The only difference between a numeric and string

GENERAL PILOT OP-CODES (COMMANDS)

COMMAND	FORMAT	BRIEF DESCRIPTION
ACCEPT	A: A:variable AS:	Enter answer Enter answer to variable Enter one character answer
BIT-PATTERN	B:number	Set bit pattern for specified sprite
CALL	Z:value	Executes machine code at address specified by value
COMPUTE:	C:t=e	Assigns variable t with value e
CONTINUE	:text	Displays text after colon
DIMENSION	D:V$(length)	Dimensions specified variable
END	E: E:dest	Ends program or subroutine Returns control to destination
EXECUTE	X:V$	Executes contents of variable as Pilot instruction
FILE	FI:name FO:name FX:DOS com	Load file into buffer Save file to disk Sends command to DOS
GRAPHICA	G:op	Execute graphic operations (see separate table)
JUMP	J:label J:@A J:@P J:@M	Jump to specified label Jump to last ACCEPT instruction Jump to next PROBLEM instruction Jump to next MATCH instruction
LINK	L:name	Chain named program
MATCH	M:pattern MS:pattern MJ:pattern	Compares pattern with answer buffer Similar to above, but allows for spelling errors Jumpt to next MATCH if answer is false
NEWCHAR	N:number	Select character to be redefined
PROBLEM	PR:param	Serves as a jump, uses various parameters
REMARK	R:text	Program documentation
SPRITE	S:num;list	Controls sprite
TYPE	T:text TH:text TS:text	Displays text on screen As above, but surpresses line feed As T but clears screen window first
USE	U:label	Causes a subroutine call
VOICE	V:vlist VX:vlist	Controls sound generation Pokes values in memory



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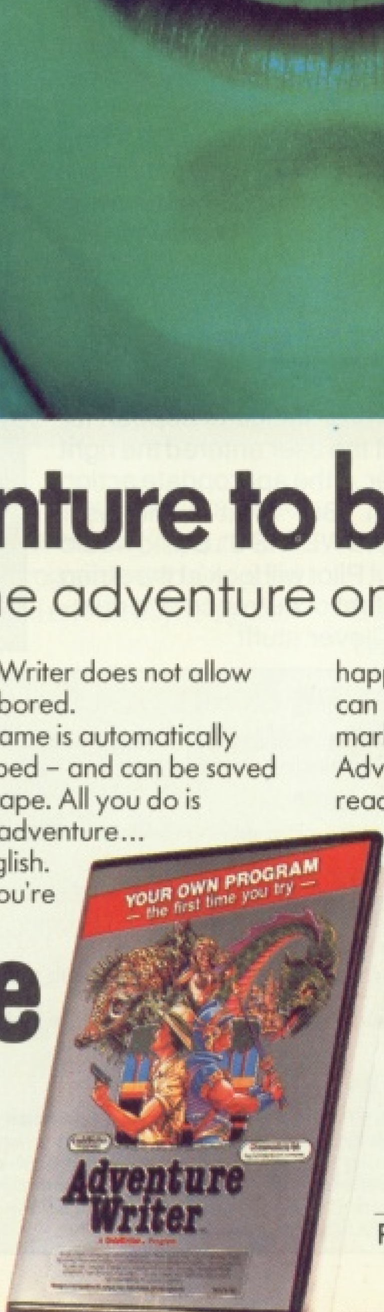
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AWYS1

PILOT

variable is that the latter must be dimensioned before use. Although not compulsory, the dollar sign can optionally follow a string variable — something that's strongly recommended as a way of identifying string variables. Subscripting is only allowed for variables that have been previously dimensioned. There are two ways to do it: first G$(6) will select the sixth character of the string, and G$(5,6) will select six characters after the fifth.

Pilot doesn't have too many bad points, but the limiting numeric range must be the number one clanger. Why? Firstly, because the language doesn't support real numbers — it's integer-only arithmetic. This wouldn't be so bad if it wasn't for the second problem. Integers can only have a range between -32768 to 32767. This is a real drawback, especially for those who would like to use the language for teaching maths. In addition, the functions offered are few in number and not very wide ranging (see Pilot Functions).

Numbers And Strings

As with Basic, Pilot allows for numbers to have calculations performed on them. This is only of real use when variables are to be assigned with target values, and this can be done with the COMPUTE instruction.

```
C:N=10*4
```

will assign to the variable N with the value of 10 multiplied by four (just as in Basic). All the normal mathematical operators found in Basic will work in Pilot, and they also take the same precedence.

The TEXT command is not designed to use double quotes to embed literals, and hence things need to be done differently when variables are to be printed in a 'T' statement. To print a numeric variable, it must be preceded by the '#' sign. Table 2 shows a Basic program with the Pilot equivalent to demonstrate the point. The third line in the Pilot program is necessary because it's not possible to do any calculations within a TEXT statement.

The assignment of string variables is handled in the COMPUTE instruction in a similar way. For instance:

```
C:X$="YOUR"
```

String assignments have double-quotes to allow for concatenation within COMPUTE statements. For example:

```
C:X$="YOUR"!!"64"
```

Here the operator '!!' is equivalent to the Basic string operator '+' which adds one string onto the end of another. Printing string variables is a little tricky as they need to be preceded by a dollar sign. For instance:

```
T:$X$
```

will print the contents of X$.

One of the most flexible features of the Pilot language is the way it accepts input using the ACCEPT instruction. If a variable is not specified in the field, input is held in the input buffer '%B' — an 80-character long string variable. For example:

```
T:HELLO THERE, WHO ARE YOU?
A:
T:PLEASED TO MEET YOU $%B
```

Note that, like all Pilot strings, the input buffer must also be preceded by the dollar sign when it's being used to display its contents in a TEXT instruction. It's all too easy to overwrite the input buffer, so it's best to immediately assign a variable with the same value. For instance:

```
D:X$(20)
T:HELLO THERE, WHO ARE YOU?
A:X$
T:PLEASED TO MEET YOU $X$
```

Data can be edited in a number of ways before being assigned either to the input buffer or a variable. The PROBLEM instruction has modifiers that allow input to be converted to upper or lower case, stripped of all spaces and more.

One very clever aspect of ACCEPTing input is that the ACCEPT instruction will remove a number from a string, allowing ambiguous answers to be processed:

```
T:WHAT IS 5 PLUS 3
A:N
T(A<>8):WRONG, THE ANSWER IS 8
T(A=8):THAT IS CORRECT!
```

You'd expect similar things to happen for Basic and Pilot if the user entered the right or wrong number ... the appropriate action would be taken. But what if the user entered 'THE ANSWER IS 8'. Basic would object to this, but Pilot will look at the string and extract the first occurrence of a number if present. Clever stuff!

Dealing With Answers

The next step to consider is the processing of answers, and here's where Pilot really comes into its own. The instruction MATCH, used with PROBLEM, allows the programmer a wide range of input variation — even though it all leads to the same answer.

MATCH on its own will look for a particular item and set a true/false flag accordingly. Let's say 'Your 64' is the string to be matched. If the answer was 'I like Your 64', the match would be true. Problems can arise if the student enters 'I like YOUR 64' with the 'YOUR' in upper case. The difficulty can be overcome by setting the value of MATCH to upper or lower case, and setting the modifier to the same. For example:

```
D:X$(20)
T:What is your favourite Commodore mag?
PR:U
A:X$
M:YOUR 64
TY:You have good taste
TN: You are missing a lot!
```

The third line from the top ensures that whatever is entered is converted to upper

PILOT FUNCTIONS

ABS(X)	Absolute value of X
ASC(X$)	Returns value between zero and 255
CAP(X$)	Converts string to upper case
CHR(X)	Returns character corresponding to X in ASCII code
FLO(X$)	Returns numeric representation of string
INS(X$)	Returns location of X$ in answer buffer %B
KEY(0)	Returns zero if no key held down, otherwise returns ASCII code
LEN(X$)	Returns the length of X$
RND(X)	Returns a pseudo-random number from 0 to X-1
RSP(X$)	Removes spaces from X$
STR(X)	Returns string representation of X
SWP(X$)	Replaces all occurrences of X$(1) in answer buffer %B with character in X$(2)

NUMERIC VARIABLES

Basic Program

```
10 LET A=4
20 LET B=76
30 PRINT A;" PLUS ";B;" EQUALS ";A+B
```

Pilot equivalent

```
C:A=4
C:B=76
C:X=A+B
TH:£A PLUS £B EQUALS £X
```

PILOT AT THE CONTROLS

To make things a little clearer, here are some examples. To simply print 'HELLO' on the screen the instruction would be:

```
T:HELLO
```

If we wanted to clear the screen before printing, we'd include the modifier 'S'

```
TS:HELLO
```

A conditioner can simply be added

```
TS(A=B): HELLO
```

If A equals B the screen will be first cleared and 'HELLO' then printed.

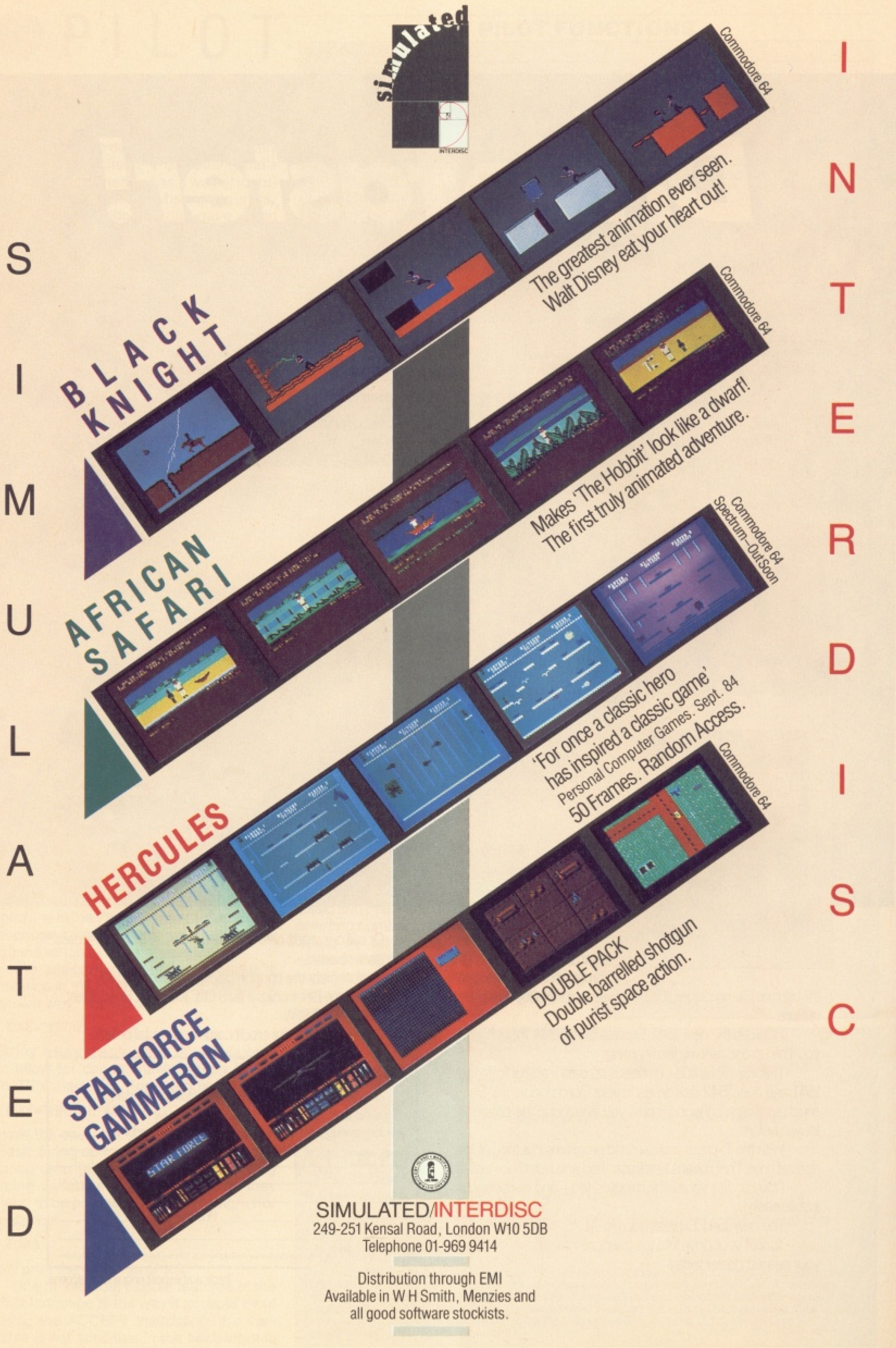
Another example is where you're using the field for something other than printing text:

```
G:E;P5,5;D100,100
```

This may look a little daunting, but it's not really. All we've done is to use the command Graphics. Following it in the field are three graphic commands: the first 'E' simply clears the screen; this is followed by the semi-colon to separate it from the next command 'P' which plots a single dot at coordinates 5,5 (note the comma); this in turn is separated from the last command by a semi-colon, where 'D' draws a line to location 100,100 on the screen.

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GRAPHIC OPERATIONS

COMMAND	FORMAT	BRIEF DESCRIPTION
BACKGROUND	Bn	Sets background colour to n
COLOUR	Cn	Sets foreground colour to n
DRAW	Dx,y	Draws line from current position to location at x,y
ERASE	E	Erases screen
EXTERIOR	Xn	Sets outer screen border to colour n
FILL	Fx,y	Fills a rectangle with current foreground colour
MOVE	Mx,y	Moves graphic beam to location x,y
OFFSET	Ox,y	Moves screen coordinates origin to x,y
POINT	Px,y	Plots a point and moves beam to x,y
REMOVE	Rx,y	Erases line from current position to x,y
SPLIT	Sn	Splits screen using a parameter n
TEXT-CURSOR	T	Moves text cursor to graphic beam location
UNPOINT	Qx,y	Erases dot at location x,y

Note; all Graphic Operations are preceded by the letter "G"

SPRITE OPERATIONS

COMMAND	FORMAT	BRIEF DESCRIPTION
ENABLE	E1	Make sprite visible
DISABLE	E0	Make sprite invisible
MULTI-COLOUR	M1	Place sprite in multi-colour mode
NORMAL COLOUR	M0	Place sprite in single colour mode
DOUBLE X-SIXE	X1	Double the horizontal size of sprite
SINGLE X-SIZE	X0	Reset sprite to normal horizontal size
DOUBLE Y-SIZE	Y1	Double the vertical size of sprite
SINGLE Y-SIZE	Y0	Reset sprite to normal vertical size
PRIORITY-ON	P1	Sprite will be displayed behind background data
PRIORITY-OFF	P0	Sprite will be displayed in front of background data
COLOUR	Cn	Set foreground colour of sprite to n
LOCATION	Lx,y	Move sprite to location x,y
R-COLOUR	Rn	Set R colour to n
Q-COLOUR	Qn	Set Q colour to n

Note; all Sprite Operations are preceded by the letter "S"

case. This answer is then placed into the string variable X$. The MATCH then 'searches' the variable for an upper case 'YOUR 64'; if found, the flag is set to true — if not, to false. The last two lines are TEXT instructions with the true Y, and false N modifiers. Thus the line before last could read 'if the result of the match was true, print the following text'.

This is a very flexible feature of Pilot; input can be any mixture of upper and lower case and still PROBLEM will convert it and MATCH will test it. This testing can be further improved by adding the S modifier, which will accept input with one letter wrong, or a pair of letters swapped around!

And there's more, because wildcards '*' can be used — for example 'M:Yo*r 64' will accept any character for the 'u'. You can use any number of wildcards you like, and going further still, the '&' is used as a multiple wildcard — so 'M:Y&r 64' will accept any number of characters in place of 'ou'. Finally, the '!' in a MATCH will act as an OR. Thus a MATCH with 'M:Your 64!64 Your' will set the flag true if either are found.

Jumping About

Sequential programming can be boring to say the least, and unlike Basic, Pilot has no line numbers. The only other way to get to another part of a Pilot program is to JUMP to a label. In its simplest form the JUMP instruction is as follows:

```
C:A=1
*LOOP
T:#A
C:A=A+1
J:LOOP
```

A label is specified by preceding it with an asterisk, and each label can be set up to six letters long. The actual JUMP instruction must include the name of the label to which you're jumping, and this is placed after the colon — that is, in the field.

In its present form, the JUMP instruction is no more than a Basic GOTO, but with just a few modifiers (handy, aren't they!) things are very different. The first modifier you can use is the true/false flag. Once the JUMP instruction incorporates this, tests can be made:

```
D:A$(10)
*START
T:What is the capital city of England?
PR:U
A:AS
M:LONDON
TY:Well done, it is London
TN:Sorry, try again ...
JY:NEXT
JN:START
*NEXT
T:Is Y64's managing director the greatest?
```

In this example, the JUMP instruction would go to label START if the answer were incorrect, and on to NEXT if all were well. The problem with this method of jumping is that it uses up a lot of labels and things can be simplified with the help of JUMP modifiers: '@ A' allows the program to JUMP to the last used ACCEPT; '@ P', to JUMP to the next PROBLEM; '@ M' to JUMP to the next MATCH.

The JUMP instruction that incorporates these modifiers allows for far greater program control during the processing of user input. Questions can be repeated, or put another way, different questions can be asked — and so on.

The micro is sometimes described as the ever-patient tutor that doesn't bite. To actually achieve this worthy aim without being 'mechanical' is difficult for many languages, but not with Pilot. It's even possible to give 'hints' if questions are incorrectly answered — by placing a number after the 'T' instruction. Pilot keeps count of how many times the same ACCEPT has been executed, and the micro can respond accordingly. For example:

```
D:XS(5)
T:What is the name of an edible crystal T:that is
used by us all every day?
PR:U
A:XS
M:SUGAR
TY:Yes sugar.
JY:@P
TH:No
T1:It's white.
T2:It's a sweetener.
T3:You use it in tea and coffee.
J:@A
PR:
.
.
```

Each time the user gets the question wrong, a new hint is displayed. After the third hint, any more wrong answers will result in 'No' being displayed.

Pilot In Perspective

This has been but a brief introduction to the Pilot language and its applications. There are some instructions which have not been discussed — such as subroutines, graphics, sound and file handling; sadly, I have only the space for a summary, rather than a tutorial. (I can tell you that the graphic instructions are quite impressive, although the sound instruction is not!)

The Commodore version operates very well, and is easy enough to get started with. There are no masses of instructions to learn and the editing facilities offered are excellent. And like Basic, ideas can be tried out in an inmediate mode — which helps in learning the language.

Pilot is a very powerful input processing language, and as such could suit the needs of many educationalists. Whether it will ever undergo mass adoption in this country is a question I leave for others to answer. For me, though, it certainly contains the ingredients for success.

SCRATCHPAD

Scratchpad *is* Y64s
section for hints, tips and utility programs. Reader submissions are welcomed — machine code or Basic, long or short, send them to:
Scratchpad, Y64, 14 Rathbone Place, London W1P 1DE.

Calculated Input

Some micros allow mathematical expressions to be entered as a string (like the BBC's EVAL function) or provide a calculator (like the Apricot) from which the result may be transferred to the input. The only way to do this on the 64 is to break out of the program, perform the calculations in direct mode and then resume program execution with a CONT.

In a numerical program I was recently working on I wrote this simple calculator routine which could be called as required. It was called if the response to an input was 'C*'. This meant all input where the calculator could be called had to be performed using strings. These were then converted to numbers with VAL(). The input looked something like:

```
1110 INPUT"NUMBER";N$
1120 IF N$="C*" THEN GOSUB
60000: NUMBER=X:GOTO 1140
1130 NUMBER=VAL(N$)
```

The calculator subroutine listing is given:

```
60070 IF Q$="." GOTO 60090
60080 IF Q$<"0" OR Q$>"9" GOTO 60030
60090 Y$=Y$+Q$:PRINTQ$;:GOTO 60030
60100 REM OPERATORS
60110 Y=VAL(Y$):IF Y=0 GOTO 60180:REM ZERO OPERAND ILLEGAL
60120 IF OP$="^" THEN X=X^Y:REM EXP
60130 IF OP$="/" THEN X=X/Y:REM DIV
60140 IF OP$="*" THEN X=X*Y:REM MULT
60150 IF OP$="+" THEN X=X+Y:REM ADD
60160 IF OP$="-" THEN X=X-Y:REM SUB
60170 IF OP$="=" AND Y$<>"" THEN X=Y:REM EQUAL
60180 OP$=Q$:Y$="":GOTO 60020
60190 RETURN
60000 REM SIMPLE CALCULATOR SUBROUTINE
60010 OP$="+":X=0:Y$=""
60020 PRINT"[HOM]";SPC(20);"[20SPC][HOM]";SPC(20);"[REV]";X;
OP$;"[OFF] ";
60030 GET Q$:IF Q$="" GOTO 60030
60040 IF Q$="[F7]" GOTO 60190:REM EXIT ON F7
60050 IF Q$="[F1]" GOTO 60010:REM NEW CALC ON F3
60060 IF Q$="^" OR Q$="/" OR Q$="*" OR Q$="+" OR Q$="-" OR
Q$="=" GOTO 60110
```

The routine uses the variables Q$, Y$, OP$, X and Y. Remember that these variables will be changed through its use so change the names to avoid conflict with your program if necessary. On calling the subroutine, the current total is displayed at the top right of the screen followed by the current operator with both being in reverse video. The value typed in appears to the right of these. Exponentiation, multiplication, division, addition, subtraction and equals are supported. The display is updated after pressing an operator (Λ */ +—=). 'Equals' is simply used to perform the final calculation. After pressing equals the current value is retained and acted upon. If a number is entered, it replaces the current value. Numbers in exponential E format are accepted and converted correctly by BASIC's VAL() function and may therefore be used in the routine. The final controls are via the function keys. 'F7' returns to the point in the program from which it was called and F1 clears the calculator for a new sum.

Machine Code Master

MONIT-64, by Adam Harrison, is a utility no 64 programmer should be without. It's an easy to use assembler, disassembler, monitor and machine code monitor — all in one convenient program! And although it's written entirely in Basic, it supports most of the facilities offered in commercial simple assemblers.

When typing in the program, please note that the left-arrows in the DATA statements are optional but each DATA line *must* contain the same number of commas. The program has a built-in 'checksum' routine at line 4000 that will check the DATA for you and detect most errors. To use it, type GOTO 4000 before RUNning the program for the first time; if there's an error in the DATA for an instruction, it will print "wrong" alongside the instruction. These errors must be corrected before RUNning, as even a single misplaced comma could cause the program to crash and result in your work being lost.

Once you've corrected any errors, SAVE and verify the program before RUNning. When RUN, you'll be presented with a menu of six options:
1. Modify memory (machine code loader)
2. Memory dump (monitor)
3. Disassembler
4. Assembler
5. Save (a machine code program)
6. Load (a machine code program)

Modify Memory

This is really a simple machine code loader. It enables you to enter hex-dumps (like the one given for *Firing-up Basic* in issue 1) directly into memory. You'll be prompted firstly for the start address, normally C000. Once you've entered this, MONIT-64 will prompt you with this address and wait for you to enter a 2-digit hex value. If this value is incorrect, the cursor will reposition itself and wait for you to re-enter the value. When a valid code has been entered, the cursor will jump to the next column ready for the next value. When eight values have been entered, you'll be prompted with a new address ready for the next eight bytes. When you've finished, enter ** to return to the main menu. For example (user input in bold print):

START ADDRESS? C000
C000 A9 78 C6 78 34 21 00 44
C008 **

Memory Dump

This is the complement of the above. It performs a hex dump from the specified address. While the dump is in progress, the following keys apply:

F1 Pauses the dump
F3 Changes the text colour
F5 Jumps forward by 512 bytes (2 'pages')
F7 Jumps back by 512 bytes (2 'pages')
Any other key returns you to the main menu

Disassemble

This produces a scrolling disassembly of any area of memory in standard 6510 assembly code. Bytes that can't be translated into valid assembler code will be displayed as '???'.

The following function keys may be used:

F1 Pauses the disassembly
F3 Changes the text colour
F5 Returns to the 'Start address?' prompt
F7 Stop disassembler and call the assembler
Any other key returns you to the main menu.

A sample disassembly might look like this:

```
A474 A976 LDA £$76
A476 A0A3 LDY £$A3
A478 201EAB JSR $ABIE
```

(etc)

Assemble

The assembler option is a simple assembler comparable to, say, Commodore's *Supermon 64*. It will accept standard 6510/6502 assembly language instructions and assemble the code into memory. It is suitable for use with the *Y64 Machine Code Tutor* series, though we would

recommend that you buy a full assembler as well (see *Y64, issue 3, pp.44-46* for details of assemblers).

As well as accepting the standard 6510 instruction set, *Monit-64* adds ten extra instructions (sometimes known as pseudo op-codes) to make life easier. These are:

BIN Returns the binary equivalent of a decimal number up to 32767. In the case of numbers greater than 255, the binary equivalent of the low-byte is returned. For example, BIN 254 returns 11111110.
DEC Returns the decimal equivalent of a 4-digit hexadecimal number between 0 and 65535.
For example, DEC 00C0 returns 192.
HEX Returns the hexadecimal equivalent of a decimal number between 0 and 65535. For example, HEX 256 returns 0100.
ASC Returns the CBM ascii code of a character. For example, ASC A returns 65.
SCR Returns the screen POKE value of a character. For example, SCR A returns 1.
COLOUR Sets the screen and border colours to their default values.
FREE Forces 'garbage collection' (freeing unusued RAM) and returns the number of free bytes available afterwards.
POKE Has the same effect as the Basic POKE statement, and is performed in decimal, but the comma must be replaced with a minus sign ('-').
For example, POKE 650-255.
SYS Has the same effect as EXEC, but the start address should be entered in decimal. The machine code program to be executed must be terminated with an RTS statement as usual, but this will return control to MONIT-64 rather than to Basic.
D Passes control to the disassembler. It may optionally be followed by a start address in four-digit hex form.
For example, D C000.

To write an assembly language program, enter the command A followed by the start address and then the first instruction. For example:

A C000 ASL A

MONIT-64 will then respond with a disassembly of the address written to:

A C000 0A ASL A

followed by prompting you with the next address. Spaces are optional (you can enter as many or as few as you like: MONIT-64 removes them all automatically). Entering assembly language code is straightforward, but please note the following points:

- The start address must be given in hex, but *not* preceded by a dollar sign
- All other values should, of course, be in hex and must be preceded by a dollar sign ('$').
- Full stops ('.') are used in place of commas (','). For example, 'LDA($2C).Y' instead of 'LDA($2C),Y'.
- Implied addressing mode instructions must be followed by an 'A'. For example, 'LSR' would be entered as 'LSR A'.

The three other commands you need to know are:

SAVE Saves an area of memory to tape as an unnamed file. This can be reloaded using the LOAD command.
LOAD Loads the first file on the tape. Don't attempt to load Basic programs! If you do, MONIT-64 will probably crash.
EXIT Exit the assembler and return to the MONIT-64 menu.

If your machine code program crashes MONIT-64, or you accidentally press the RUN/STOP key, enter GOTO 6 as a direct command. This will restart MONIT-64 without losing your program.

Lines 6-8 Sets up arrays for disassembler and assembler, and array for memory dump.

Line 9-110 Memory modify.

```
6 CLOSE1:IFS(1)=2015ANDS(2)=S(1)+1ANDS(3)=S(2)+1THEN120
7 DIMAS$(56,13),DI$(255,2),SV%(18):GOSUB885
8 Q=0:FORI=8TO1STEP-1:Q=Q+1:S(I)=2023-Q:NEXT:GOTO120
9 REM ************MEM MODIFY**********
10 POKE53281,6:POKE53280,6:PRINT"■■◢"
20 PRINT" HEX DUMP INPUT PROGRAM.     *******"
30 PRINT"■READY.■■"
40 A$="":SA$="":PRINT"■INPUT THE START ADDRESS.":INPUTSA$:IFSA$="**"THEN120
45 E=0:IFLEN(SA$)<>4THENPRINT"■■":GOTO40
50 GOSUB300:SA=Q:POKE198,0:REM DEC-HEX
55 IFER=1THENPRINT"?????????????????????????":GOTO40
```

Lines 60-70 Uses INPUT# so that there is no '?' and carriage returns don't affect the position of the cursor.

```
60 GOSUB450:PRINTQ$;CHR$(13)"■▮▮▮▮▮▮▮▮▮";:OPEN1,0:FORI=1TO8:IFE=1THEN100
70 INPUT#1,A$:IFLEN(A$)<>2THENPRINT"■■■■";:GOTO70
71 IFA$="**"THENE=1:GOTO100
75 GOSUB350:IFER=1THENPRINT"■■■";:GOTO70
76 POKESA,Q:SA=SA+1
80 PRINT"■";
100 NEXTI:CLOSE1:PRINT"■":IFE=1GOTO120
110 GOTO60
120 PRINT"■■"TAB(13);"MONIT-64 "
125 PRINT"■■■■"TAB(8);" [F1]   -  MEMORY MODIFY."
130 PRINTTAB(8);"■ [F3]   -  MEMORY DUMP.":POKE53281,0:POKE53280,0
140 PRINTTAB(8);"■ [F5]   -  ASSEMBLER.":POKE198,0
145 PRINTTAB(8);"■ [F7]   -  DISSASSEMBLER.":POKE198,0
146 PRINTTAB(8);"■■ [S]    -  SAVE."
147 PRINTTAB(8);"■ [L]    -  LOAD."
149 PRINT"■■■■   PRESS THE KEY FOR THE FUNCTION YOU          REQUIRE."
150 GETR$:IFR$<>"■"ANDR$<>"▀"ANDR$<>"▐"ANDR$<>"▌"ANDR$<>"S"ANDR$<>"L"THEN150
151 IFR$="▌"THEN1500
155 IFR$="■"THEN10
156 IFR$="▐"THEN500
158 IFR$="L"THENPRINT"■";:GOTO3600
159 IFR$="S"THEN3610
```

Lines 160-191 Memory dump. (If no characters appear on the right hand side of the screen, you have an old ROM. Simply add 182 POKE S(I)+54272,13).

```
160 PRINT"■■INPUT START ADDRESS.":INPUTSA$:IFLEN(SA$)><4THENPRINT"■":GOTO160
170 GOSUB300:SA=Q:IFER=1THENPRINT"■":GOTO160
171 POKE198,0:PRINT"■◘◘◘◘◘◘◘◘◘◘◘◘◘◘◘◘◘◘◘◘◘◘◘◘◘◘◘◘◘◘◘◘◘◘"
175 GOSUB450:PRINTQ$;TAB(5);:IFSA>=65535ORSA+8>65535THENSA=0
180 FORI=1TO8:A=PEEK(SA):GOSUB400:PRINT" "Q$;:SA=SA+1:POKES(I),(A-64)AND255
185 NEXT:PRINT:IFPEEK(198)=0THENPOKE198,0:GOTO175
186 GETR$:IFR$="■"THENPOKE198,0:WAIT198,1:POKE198,0:GOTO175
187 IFR$="▀"THENPOKE646,(PEEK(646)+1)AND255:GOTO175
188 IFR$="▐"THENSA=SA-512:IFSA<0THENSA=65535+SA
189 IFR$="▌"THENSA=SA+512:IFSA>65535THENSA=SA-65535
190 IFR$="▐"ORR$="▌"THEN175
191 GOTO120
```

Lines 300-320 Subroutine to convert the hexadecimal string SA$ into a decimal value in Q.

```
300 ER=0:C=0:Q=0:Q$=SA$:FORX=3TO0STEP-1:C=C+1
305 S=ASC(MID$(Q$,C,1)):IFS=>65ANDS<=70THENS=S-55:GOTO310
307 S=S-48
310 IFS>16THENER=1
315 Q=Q+(S*(16↑X)):NEXT:IFQ>65536ORQ<0THENER=1
320 RETURN
```

Lines 350-370 The same as above, only it converts a 2-digit hex string A$ into a decimal variable Q.

```
350 ER=0:C=0:Q=0:Q$=A$:FORX=1TO0STEP-1:C=C+1
355 S=ASC(MID$(Q$,C,1)):IFS=>65ANDS<=70THENS=S-7
357 S=S-48
```

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```
360 IFS>16THENER=1
365 Q=Q+(S*(16↑X)):NEXT:IFQ>255ORQ<0THENER=1
370 RETURN
```

Lines 400-420 Subroutine to convert variable A into hex string Q$ (2 digit).

```
400 Q$="":Q=INT(A/16)
405 QQ=A-(Q*16)
410 IFQ>9THENQ$=CHR$(Q+55)
411 IFQ<=9THENQ$=RIGHT$(STR$(Q),1)
415 IFQQ>9THENQ$=Q$+CHR$(QQ+55)
416 IFQQ<=9THENQ$=Q$+RIGHT$(STR$(QQ),1)
420 RETURN
```

Lines 450-480 Same as above, but converts SA to Q$ (4 digit).

```
450 Q$="":Q=SA:FORI=1TO4
455 Q=Q/16:QQ(I)=INT((Q-INT(Q))*16)
460 NEXT:FORI=4TO1STEP-1
470 IFQQ(I)>9THENQ$=Q$+CHR$(QQ(I)+55):GOTO480
475 Q$=Q$+RIGHT$(STR$(QQ(I)),LEN(STR$(QQ(I)))-1)
480 NEXT:RETURN
```

Lines 500-650 The assembler input routine. To eliminate the '?' flags normally produced during the input command, INPUT# is used again. This makes movement about the screen easier, and simulates the screen in direct mode.

```
500 PRINT"]■   ASSEMBLER UTILITY  ******":POKE53281,6:POKE53280,6
510 PRINT"█READY.":POKE198,0
520 OPEN1,0,0:INPUT#1,A$:PRINT:CLOSE1
522 IFA$="COLOUR"THENPOKE53280,14:PRINT:GOTO510
525 IFA$=""THENPRINT"]":GOTO520
530 IFLEFT$(A$,3)<>"DEC"THEN550
540 SA$=RIGHT$(A$,4):GOSUB300:PRINTQ:GOTO510
550 IFLEFT$(A$,3)<>"HEX"THEN570
560 SA=VAL(RIGHT$(A$,LEN(A$)-3)):GOSUB450:PRINTQ$:GOTO510
570 IFA$="EXIT"THEN6
574 IFLEFT$(A$,3)="SYS"THENQ=VAL(RIGHT$(A$,LEN(A$)-3)):PRINT"]S."Q :GOSUB2000
575 IFLEFT$(A$,4)="EXEC"THENSA$=RIGHT$(A$,4):GOSUB300:PRINT"]E."Q:GOSUB2000
576 IFLEFT$(A$,4)="EXEC"ORLEFT$(A$,3)="SYS"THEN510
580 IFA$="LOAD"THEN3600
581 IFLEFT$(A$,3)="ASC"THENPRINTASC(RIGHT$(A$,1)):GOTO510
585 IFA$="SAVE"THEN3610
590 IFA$="FREE"THENA=FRE(0):IFSGN(A)=-1THENA=A+70360
591 IFLEFT$(A$,3)<>"SCR"THEN595
592 A$=RIGHT$(A$,1):PRINT(ASC(A$)AND128)/2OR(ASC(A$)AND63):GOTO510
595 IFA$="FREE"THENPRINTA" BYTES FREE.":GOTO510
600 IFLEFT$(A$,4)="POKE"THENGOSUB1100:POKEQ,QQ:GOTO510
605 IFLEFT$(A$,3)="BIN"THENA=VAL(RIGHT$(A$,LEN(A$)-3)):GOSUB700:PRINTQ$:GOTO510
610 IFLEFT$(A$,1)="D"ANDLEN(A$)=>5THENSA$=RIGHT$(A$,4):GOTO1507
620 IFLEFT$(A$,1)="A"ANDLEN(A$)=>8THEN1700
630 IFLEFT$(A$,1)="A"THEN510
650 PRINT"?INVALID COMMAND ERROR.":GOTO510
```

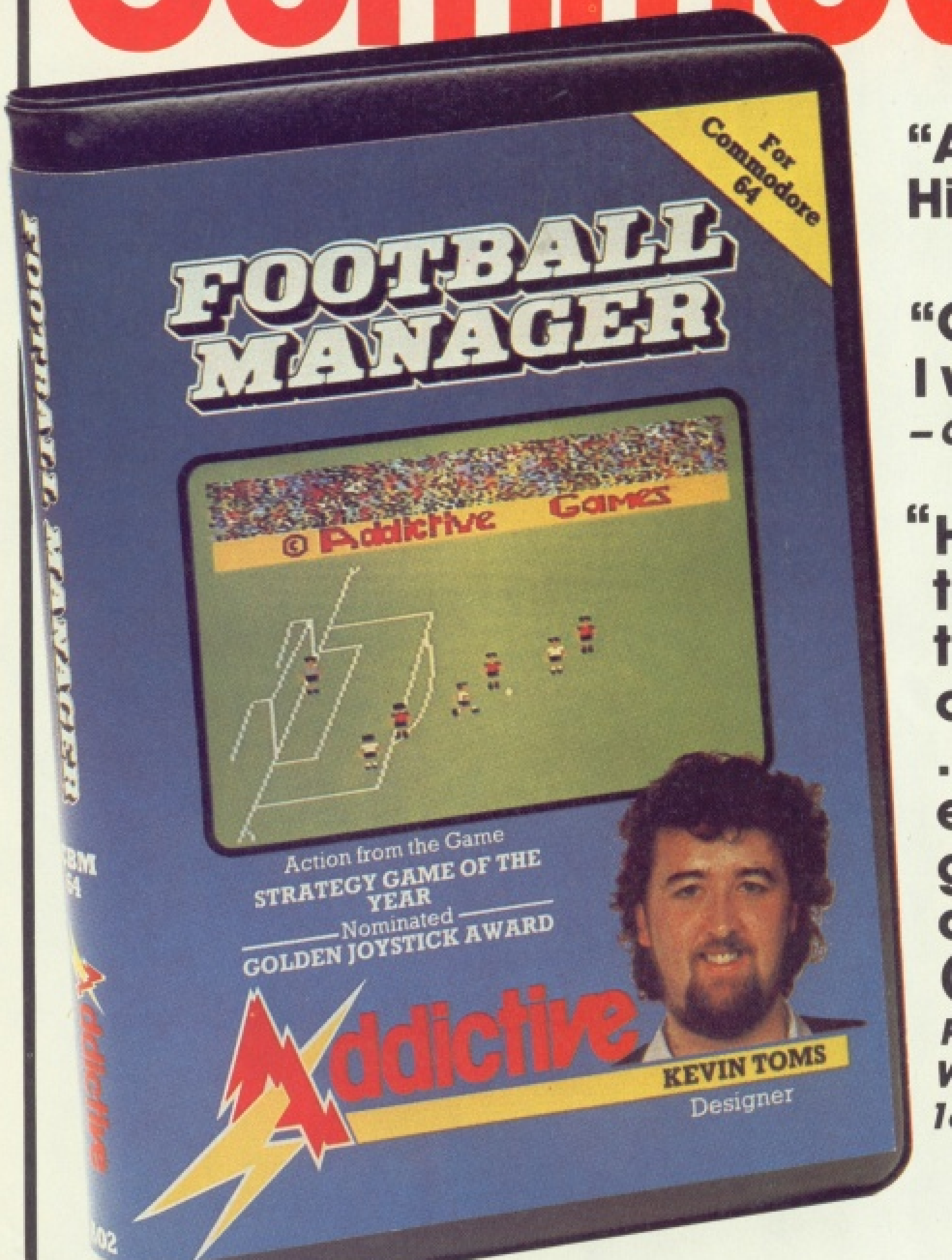
Lines 700-720 Subroutine to convert the decimal value of 'A' into an 8 bit binary string Q$.

```
700 IFA>32767THENQ$="":RETURN
705 Q$="":A=A AND 255:FORI=7TO0STEP-1
710 IF(A AND (2↑I))>0THENQ$=Q$+"1":GOTO720
715 Q$=Q$+"0"
720 NEXT:RETURN
```

Lines 800-885 Data for the assembler and disassembler.

```
800 DATABRK,1,ORA,2,,,,ORA,3,ASL,3,,PHP,1,ORA,4,ASL,5,,
802 DATAORA,6,ASL,6,,BPL,10,ORA,8,,,,ORA,12,ASL,12,,CLC,1
805 DATAORA,8,,,,ORA,7,ASL,7,,JSR,6,AND,2,,,BIT,3,AND,3,ROL,3,
807 DATAPLP,1,AND,4,ROL,5,,BIT,6,AND,6,ROL,6,,BMI,10
810 DATAAND,9,,,,AND,12,ROL,12,,SEC,1,AND,8,,,,AND,7
815 DATAROL,7,,RTI,1,EOR,2,,,,EOR,3,LSR,3,,PHA,1,EOR,4
817 DATALSR,5,,JMP,6,EOR,6,LSR,6,,BVC,10,EOR,9,,,,EOR,12,LSR,12
820 DATA,CLI,1,EOR,8,,,,EOR,7,LSR,7,,RTS,1,ADC,2,,,
822 DATAADC,3,ROR,3,,PLA,1,ADC,4,ROR,5,,JMP,13,ADC,6,ROR,6,,BVS,10,ADC,9
825 DATA,,,ADC,12,ROR,12,,SEI,1,ADC,8,,,,ADC,7,ROR,7,,
827 DATASTA,9,,,STY,3,STA,3,STX,3,,DEY,1,,TXA,1,,STY,6
830 DATASTA,6,STX,6,,BCC,10,STA,9,,,STY,12,STA,12,STX,11,
832 DATATYA,1,STA,8,TXS,1,,,STA,7,,,LDY,4,LDA,2
835 DATALDX,4,,LDY,3,LDA,3,LDX,3,,TAY,1,LDA,4,TAX,1,
837 DATALDY,6,LDA,6,LDX,6,,BCS,10,LDA,9,,,LDY,12,LDA,12,LDX,11,,CLV,1
840 DATALDA,8,TSX,1,,LDY,7,LDA,7,LDX,8,,CPY,4,CMP,2,,
842 DATACPY,3,CMP,3,DEC,3,,INY,1,CMP,4,DEX,1,,CPY,6,CMP,6
845 DATADEC,6,,BNE,10,CMP,9,,,,CMP,12,DEC,12,,CLD,1
847 DATACMP,8,,,,CMP,7,DEC,7,,CPX,4,SBC,9,,,CPX,3,SBC,3,INC,3
850 DATA,INX,1,SBC,4,NOP,1,,CPX,6,SBC,6,INC,6,,BEQ,10
852 DATASBC,9,,,,SBC,12,INC,12,,SED,1,SBC,8,,,,SBC,7,INC,7,
853 DATAADC,AND,ASL,BCC,BCS,BEQ,BIT,BMI,BNE,BPL,BRK,BVC,BVS,CLC,CLD,CLI,CLV
854 DATACMP,CPX,CPY,DEC,DEX,DEY,EOR,INC,INX,INY,JMP,JSR,LDA,LDX,LDY,LSR,NOP
855 DATAORA,PHA,PHP,PLA,PLP,ROL,ROR,RTI,RTS,SBC,SEC,SED,SEI,STA,STX,STY,TAX,TAY
856 DATATSX,TXA,TXS,TYA
857 DATA,61,65,69,,6D,7D,79,71,,,75,,,21,25,29,,2D,3D,39,31,,,35,
858 DATA,,06,,0A,0E,1E,,,,,16,,,,,,,,,,,,90,,,
859 DATA,,,,,,,,,B0,,,,,,,,,,,,,,F0,,,,,,,24,,,,2C,,,,,,,,,,,,,,,,
860 DATA,30,,,,,,,,,,,,,,D0,,,,,,,,,,,,,,10,,,,
861 DATA00,,,,,,,,,,,,,,,,,,,,,,,50,,,,,,,,,,,,,
862 DATA70,←,←,←,18,←,←,←,←,←,←,←,←,←,←,←,←,D8,←,←,←,←,←,←,←,←,←,←,←,←,58
863 DATA←,←,←,←,←,←,←,←,←,←,←,←,B8,←,←,←,←,←,←,←,←,←,←,←,←,←,C1,C5,C9,←,CD
864 DATADD,D9,D1,←,←,D5,←,←,←,E4,E0,←,EC,←,←,←,←,←,←,←,←,←,C4,C0,←,CC,←,←,←,←,←
865 DATA←,←,←,←,C6,←,←,CE,DE,←,←,←,←,D6,←,CA,←,←,←,←,←,←,←,←,←,←,←,←,88,←,←,←
866 DATA←,←,←,←,←,←,←,←,←,←,41,45,49,←,4D,5D,59,51,←,←,55,←,←,←,E6,←,←,EE,FE,←
867 DATA←,←,←,F6,←,E8,←,←,←,←,←,←,←,←,←,←,←,←,C8,←,←,←,←,←,←,←,←,←,←,←,←,←,←,←
868 DATA←,←,4C,←,←,←,←,←,←,6C,←,←,←,←,←,20,←,←,←,←,←,←,←,←,A1,A5,A9,←,AD,BD,B9
869 DATAB1,←,←,B5,←,←,←,A6,A2,←,AE,←,BE,←,←,B6,←,←,←,←,A4,A0,←,AC,BC,←,←,←,←
870 DATAB4,←,←,←,46,←,4A,4E,5E,←,←,←,56,←,,EA,←,←,←,←,←,←,←,←,←,←,←,←,←,01,05,09
871 DATA←,0D,1D,19,11,←,←,15,←,48,←,←,←,←,←,←,←,←,←,←,←,←,08,←,←,←,←,←,←,←,←,←
872 DATA←,←,←,68,←,←,←,←,←,←,←,←,←,←,←,←,28,←,←,←,←,←,←,←,←,←,←,←,←,←,←,26,←,2A
873 DATA2E,3E,←,←,←,←,36,←,←,←,66,←,6A,6E,7E,←,←,←,←,76,←,40,←,←,←,←,←,←,←,←,←
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```
874 DATA←,←,←,60,←,←,←,←,←,←,←,←,←,←,←,←,←,E1,E5,E9,←,ED,FD,F9,F1,←,←,F5,←,38,←
875 DATA←,←,←,←,←,←,←,←,←,←,←,F8,←,←,←,←,←,←,←,←,←,←,←,←,←,←,78,←,←,←,←,←,←,←,←,←
876 DATA←,←,←,81,85,←,←,8D,9D,99,91,←,←,95,←,←,←,86,←,←,8E,←,←,←,←,96,←,←,←,←
877 DATA84,←,←,8C,←,←,←,←,←,94,←,AA,←,←,←,←,←,←,←,←,←,←,←,←,A8,←,←,←,←,←,←,←
878 DATA←,←,←,←,BA,←,←,←,←,←,←,←,←,←,←,←,←,8A,←,←,←,←,←,←,←,←,←,←,←,←,9A,←,←,←
879 DATA←,←,←,←,←,←,←,←,←,98,←,←,←,←,←,←,←,←,←,←,←,←
880 DATA169,1,170,160,1,32,186,255,169,253,166,251,164,252,32,216,255,96
```

Lines 885-895 Subroutine to set up arrays of 6502 instruction set and the 13 addressing modes available.

```
885 PRINT"▯PLEASE WAIT WHILE DATA TABLES ARE SET UP"
886 FORI=0TO255:READDI$(I,1):IFDI$(I,1)>""THENREADDI$(I,2)
887 NEXT:POKE53280,((PEEK(53280)AND15)+1)AND15
888 FORI=1TO56:READAS$(I,0):NEXT
889 FORI=1TO56:FORK=1TO13:READA$:IFA$>""ANDA$<>"←"THENGOSUB350:AS$(I,K)=STR$(Q)
890 NEXTK:PRINTAS$(I,0),:NEXTI
891 T=0:FORI=1TO18:READSV%(I):T=T+SV%(I):NEXT
892 IFT<>2828THENPRINT"▯CHECKSUM ERROR IN 880.":END
893 RETURN
```

Lines 900-920 Subroutines to handle the disassembly of commands using each of the 13 addressing modes.

```
900 PRINTTAB(20)"▯"DI$(A,1):RETURN
901 C=A:SA=SA+1:A=PEEK(SA):GOSUB400:PRINTQ$;TAB(20)"▯"DI$(C,1)" ($"Q$",X)":RETUR
N
902 C=A:SA=SA+1:A=PEEK(SA):GOSUB400:PRINTQ$;TAB(20)"▯"DI$(C,1)" $";Q$:RETURN
903 C=A:SA=SA+1:A=PEEK(SA):GOSUB400:PRINTQ$;TAB(20)"▯"DI$(C,1)" #$"Q$:RETURN
904 PRINTTAB(20)"▯"DI$(A,1)" A":RETURN
905 C=A:SA=SA+1:A=PEEK(SA):GOSUB400:PRINTQ$;:P$=Q$:SA=SA+1:A=PEEK(SA):GOSUB400
906 PRINTQ$;TAB(20)"▯"DI$(C,1)" $"Q$P$:RETURN
907 C=A:SA=SA+1:A=PEEK(SA):GOSUB400:PRINTQ$;TAB(20);"▯"DI$(C,1)" $";
908 IF(A AND 128)>0THENDI=SA:A=255-A:SA=SA-(A AND 127):GOTO910
909 DI=SA:SA=SA+A+1
910 GOSUB450:PRINTQ$:SA=DI:RETURN
911 C=A:SA=SA+1:A=PEEK(SA):GOSUB400:PRINTQ$;TAB(20)"▯"DI$(C,1)" ($"Q$"),Y"
912 RETURN
913 C=A:SA=SA+1:A=PEEK(SA):GOSUB400:PRINTQ$;:P$=Q$:SA=SA+1:A=PEEK(SA):GOSUB400
914 PRINTQ$;TAB(20)"▯"DI$(C,1)" $"Q$P$",X":RETURN
915 C=A:SA=SA+1:A=PEEK(SA):GOSUB400:PRINTQ$;TAB(20)"▯"DI$(C,1)" $"Q$",X":RETURN
916 C=A:SA=SA+1:A=PEEK(SA):GOSUB400:PRINTQ$;:P$=Q$:SA=SA+1:A=PEEK(SA):GOSUB400
917 PRINTQ$;TAB(20)"▯"DI$(C,1)" $"Q$P$",Y":RETURN
918 C=A:SA=SA+1:A=PEEK(SA):GOSUB400:PRINTQ$;:P$=Q$:SA=SA+1:A=PEEK(SA):GOSUB400
919 PRINTQ$;TAB(20)"▯"DI$(C,1)" ($"Q$P$")":RETURN
920 C=A:SA=SA+1:A=PEEK(SA):GOSUB400:PRINTQ$;TAB(20)"▯"DI$(C,1)" $"Q$",Y":RETURN
995 END
999 END
1100 Q=VAL(RIGHT$(A$,LEN(A$)-4)):IFQ<0ORQ>65535THENQ=53281:QQ=PEEK(53281)
```

Lines 1101-1120 Subroutines to handle 'POKE' command, etc.

```
1101 IFLEN(A$)-4-LEN(STR$(Q))=<0THENPRINT"INCORRECT ENTRY.":Q=53281:QQ=6:GOTO112
0
1105 QQ=VAL(RIGHT$(A$,LEN(A$)-4-LEN(STR$(Q))))
1115 IFQQ>255ORQQ<0THENQQ=53281:Q=PEEK(53281)
1120 RETURN
```

Lines 1500-1650 The disassembler. The ON...GOSUB...,.. command is used to call the 13 subroutines from 900 onwards.

```
1500 PRINT"▯▯":POKE53281,2:POKE53280,2
1505 A$="":SA$="":PRINT"▯INPUT THE START ADDRESS.":INPUTSA$
1506 E=0:IFLEN(SA$)<>4THENPRINT"▯▯":GOTO1505
1507 GOSUB300:Q$=SA$:SA=Q:POKE198,0:POKE53281,0:POKE53280,0
1508 IFSA<0ORSA>65535THEN1500
1510 A=PEEK(SA):PRINT"▯"Q$"   ▯";:GOSUB400:A=PEEK(SA):PRINTQ$;
1511 IFDI$(A,1)=""THENPRINTTAB(20)"???▯":GOTO1600
1550 ONVAL(DI$(A,2))GOSUB900,901,902,903,904,905,913,916,911,907,920,915,918
1600 IFPEEK(198)=0THENSA=SA+1:IFSA<65532THENGOSUB450:GOTO1510
1601 IFSA=>65532THENSA=-1:GOTO1600
1610 GETR$:IFR$="▯"THENPOKE53281,(PEEK(53281)+1)AND255:POKE53280,PEEK(53281)
1611 IFR$="▯"THEN1600
1620 IFR$="▯"THENPOKE198,0:WAIT198,1:POKE198,0:GOTO1600
1630 IFR$="▯"THEN1500
1640 IFR$="▯"THENPOKE53281,6:POKE53280,6:GOTO510
1650 GOTO6
```

Lines 1700-1900 The assembler. This section finds the start address for the assembly, and makes a 'guess' at the addressing mode used by searching for brackets,.X's,.Y's, and hashes ; then the subroutines at 3000- are called via the ON...GOSUB..,.. command.

```
1700 A$=RIGHT$(A$,LEN(A$)-1):IFLEN(A$)<7THENPRINT"▯▯▯▯▯▯▯▯  ???          ":GOTO1800
1710 L=LEN(A$)
1715 FORJ=1TOL:IFMID$(A$,J,1)=" "THENA$=" "+LEFT$(A$,J-1)+RIGHT$(A$,L-J)
1720 NEXTJ
1721 IFLEFT$(A$,1)=" "ANDLEN(A$)>7THENA$=RIGHT$(A$,LEN(A$)-1):GOTO1721
1722 IFLEFT$(A$,1)="$"ANDLEN(A$)>7THENA$=RIGHT$(A$,LEN(A$)-1):GOTO1722
1730 SA$=LEFT$(A$,4):GOSUB300:SA=Q:IFSA<0ORSA>65535THENA$="**":GOTO1700
1735 REM NOW FIND ADDRESSING MODE
1736 OC=1:A$=RIGHT$(A$,LEN(A$)-4):IFLEN(A$)=3THENOC=7
1737 IFRIGHT$(A$,1)="A"ANDLEN(A$)=4THENOC=5
1738 IFRIGHT$(A$,2)=".X"THENOC=3
1739 IFRIGHT$(A$,2)=".Y"THENOC=4
1740 O$="":BR=1:FORJ=1TOL
1741 IFMID$(A$,J,1)="#"THENOC=2
1748 IFMID$(A$,J,1)="("THENBR=.5
1749 IFMID$(A$,J,1)=")"THENBR=BR+.5:OC=6:IFBR=.5THENER=1
1750 NEXTJ:BR=0:IFERTHENA$="**":GOTO1700
1752 D$=LEFT$(A$,3):D=0:FORI=1TO56:IFAS$(I,0)=D$THEND=I
1753 NEXT:IFD=0THENA$="**":GOTO1700
1754 IFLEN(A$)=3ANDD$=A$THENOC=7
1755 PRINT"▯                         ▯"CHR$(13);
1756 IFAS$(D,10)>""THENOC=8
1757 ONOCGOSUB3000,3060,3100,3200,3300,3380,3340,3500
1760 IFERTHENA$="**":PRINT"A "SA$:GOTO1700
1800 GOSUB450:SA$=Q$:PRINT"A "SA$"                ▯":POKE198,9
1850 FORI=631TO639:POKEI,29:NEXT
1900 GOTO520
```

Lines 2000-2022 Places characters in the keyboard buffer to prevent a crash losing Monit-64's control of the computer. To test this, type 'EXEC C000' or SYS 49152' when there is no program at that location, and you are in the assembler option.

```
2000 POKE631,71:POKE632,207:POKE633,50:POKE634,48:POKE635,48:POKE636,53
2001 POKE637,13:POKE198,7:SYS(Q):RETURN
2005 PRINT"]=,CRASHED.":GOTO510
2022 SA=SA+1
2645 A$=RIGHT$(SA$,2):GOSUB350:IFERTHEN3610
```

Lines 3000-3050 Subroutine to handle zero page and absolute addressing modes.

```
3000 B$=SA$:B=SA
3010 SA$=RIGHT$(A$,4):GOSUB300:SA=Q:GOSUB450:IFERORQ$<>SA$THENSA$=B$:GOTO3030
3011 SA=B:L$=SA$:LH$=LEFT$(L$,2):LL$=RIGHT$(L$,2)
3012 IFAS$(D,6)=""THENER=1:SA$=B$:GOTO3050
3015 SA$=B$:B$=A$:A=VAL(AS$(D,6)):POKESA,A:GOSUB400:PRINT"A "SA$TAB(10);Q$;
3016 SA=SA+1
3020 A$=LL$:PRINTA$;:GOSUB350:POKESA,Q:SA=SA+1:A$=LH$:PRINTA$TAB(20);:GOSUB350
3022 POKESA,Q:SA=SA+1:PRINTAS$(D,0)" $"LH$LL$:GOTO3050
3030 SA=B
3031 B$=A$:A$=RIGHT$(A$,2):GOSUB350:W=Q:IFERTHEN3050
3032 A=VAL(AS$(D,3)):POKESA,A:GOSUB400:IFAS$(D,3)=""THENER=1:GOTO3050
3034 PRINT"A "SA$TAB(10);Q$;A$;
3035 SA=SA+1:POKESA,W:PRINTTAB(20)AS$(D,0)" $"A$:SA=SA+1
3050 RETURN
```

Lines 3060-3090 Subroutine to handle immediate addressing modes.

```
3060 IFAS$(D,4)=""THENER=1:GOTO3090
3065 B$=A$:A$=RIGHT$(A$,2):GOSUB350:W=Q:IFERTHEN3090
3067 A=VAL(AS$(D,4)):GOSUB400:IFERTHEN3090
3070 PRINT"A "SA$TAB(10);:POKESA,VAL(AS$(D,4)):SA=SA+1:PRINTQ$A$;
3075 POKESA,W:SA=SA+1:PRINTTAB(20)AS$(D,0)" #$"A$
3090 RETURN
```

Lines 3100-3150 Subroutine to handle absolute and zero page, X addressing modes.

```
3100 A$=LEFT$(A$,LEN(A$)-2)
3105 B$=SA$:B=SA
3110 SA$=RIGHT$(A$,4):GOSUB300:SA=Q:GOSUB450:IFERORQ$<>SA$THENSA$=B$:GOTO3130
3111 SA=B:L$=SA$:LH$=LEFT$(L$,2):LL$=RIGHT$(L$,2)
3112 IFAS$(D,7)=""THENER=1:SA$=B$:GOTO3150
3115 SA$=B$:B$=A$:A=VAL(AS$(D,7)):POKESA,A:GOSUB400:PRINT"A "SA$TAB(10);Q$;
3116 SA=SA+1
3120 A$=LL$:PRINTA$;:GOSUB350:POKESA,Q:SA=SA+1:A$=LH$:PRINTA$TAB(20);:GOSUB350
3122 POKESA,Q:SA=SA+1:PRINTAS$(D,0)" $"LH$LL$".X":GOTO3150
3130 SA=B:ER=0
3131 B$=A$:A$=RIGHT$(A$,2):GOSUB350:W=Q:IFERTHEN3150
3132 A=VAL(AS$(D,12)):GOSUB400:IFAS$(D,12)=""THENER=1:GOTO3150
3133 PRINT"A "SA$TAB(10);:POKESA,VAL(AS$(D,12)):SA=SA+1:PRINTQ$A$;
3135 POKESA,W:SA=SA+1:PRINTTAB(20)AS$(D,0)" $"A$".X"
3150 RETURN
```

Lines 3200-3250 Subroutine to handle absolute and zero page, Y addressing modes.

```
3200 A$=LEFT$(A$,LEN(A$)-2)
3205 B$=SA$:B=SA
3210 SA$=RIGHT$(A$,4):GOSUB300:SA=Q:GOSUB450:IFERORQ$<>SA$THENSA$=B$:GOTO3230
3211 SA=B:L$=SA$:LH$=LEFT$(L$,2):LL$=RIGHT$(L$,2)
3212 IFAS$(D,8)=""THENER=1:SA$=B$:GOTO3250
3215 SA$=B$:B$=A$:A=VAL(AS$(D,8)):POKESA,A:GOSUB400:PRINT"A "SA$TAB(10);Q$;
3216 SA=SA+1
3220 A$=LL$:PRINTA$;:GOSUB350:POKESA,Q:SA=SA+1:A$=LH$:PRINTA$TAB(20);:GOSUB350
3222 POKESA,Q:SA=SA+1:PRINTAS$(D,0)" $"LH$LL$".Y":GOTO3250
3230 SA=B:ER=0
3231 B$=A$:A$=RIGHT$(A$,2):GOSUB350:W=Q:IFERTHEN3250
3232 A=VAL(AS$(D,11)):GOSUB400:IFAS$(D,11)=""THENER=1:GOTO3250
3233 PRINT"A "SA$TAB(10);:POKESA,VAL(AS$(D,11)):SA=SA+1:PRINTQ$A$;
3235 POKESA,W:SA=SA+1:PRINTTAB(20)AS$(D,0)" $"A$".Y"
3250 RETURN
```

Lines 3300-3345 Subroutine to handle implied and accumulator addressing modes.

```
3300 X$=" A"
3310 IFAS$(D,5)=""THENER=1:GOTO3330
3311 O$=AS$(D,0):A=VAL(AS$(D,5))
3320 GOSUB400:IFERTHEN3330
3322 PRINT"A "SA$TAB(10);Q$TAB(20)O$X$:POKESA,A:SA=SA+1
3330 RETURN
3340 X$="":IFAS$(D,1)=""THENER=1:GOTO3330
3345 O$=AS$(D,0):A=VAL(AS$(D,1)):GOTO3320
```

Lines 3380-3450 Subroutine to handle indirect addressing modes.

```
3380 IFRIGHT$(A$,2)<>".Y"THEN3400
3385 A$=LEFT$(A$,LEN(A$)-3):REM GET RID OF INDEX & BRACKETS
3390 B$=A$:A$=RIGHT$(A$,2):GOSUB350:W=Q:IFERTHEN3450
3391 IFAS$(D,9)=""THENER=1:SA=SA-1:GOTO3450
3392 PRINT"A "SA$TAB(10);:A=VAL(AS$(D,9)):POKESA,A:GOSUB400:IFERTHEN3450
3393 PRINTQ$A$TAB(20)AS$(D,0)" ($"A$").Y"
3394 SA=SA+1:POKESA,W:GOTO3450
3400 IFRIGHT$(A$,1)<>")"THENER=1:GOTO3450
3401 A$=LEFT$(A$,LEN(A$)-1):IFRIGHT$(A$,2)<>".X"THEN3430
3402 A$=LEFT$(A$,LEN(A$)-2)
3403 B$=A$:A$=RIGHT$(A$,2):GOSUB350:W=Q:IFERTHEN3450
3404 IFAS$(D,2)=""THENER=1:SA=SA-1:GOTO3450
3405 PRINT"A "SA$TAB(10);:A=VAL(AS$(D,2)):POKESA,A:GOSUB400:SA=SA+1
3406 POKESA,W:PRINTQ$A$TAB(20)AS$(D,0)" ($"A$".X)":GOTO3450
3430 :
3431 B$=SA$:B=SA
3432 SA$=RIGHT$(A$,4):GOSUB300:SA=B:IFERTHENSA$=B$:GOTO3030
3433 L$=SA$:LH$=LEFT$(L$,2):LL$=RIGHT$(L$,2)
3434 IFAS$(D,13)=""THENER=1:SA$=B$:GOTO3050
3435 SA$=B$:B$=A$:A=VAL(AS$(D,13)):POKESA,A:GOSUB400:PRINT"A "SA$TAB(10);Q$;
3436 SA=SA+1
```


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```
3440 A$=LL$:PRINTA$;:GOSUB350:POKESA,Q:SA=SA+1:A$=LH$:PRINTA$TAB(20);:GOSUB350
3442 POKESA,Q:SA=SA+1:PRINTAS$(D,0)" ($"LH$LL$")":GOTO3050
3450 SA=SA+1:RETURN
```

Lines 3500-3550 Subroutine to handle relative addressing modes

```
3500 B$=SA$:B=SA:SA$=RIGHT$(A$,4):GOSUB300:SA=B:IFERTHENSA$=B$:GOTO3550
3502 W=Q:L$=SA$:SA$=B$:PRINT"A "SA$;TAB(10);
3505 A=VAL(AS$(D,10)):POKESA,A:GOSUB400:PRINTQ$;:SA=SA+2
3510 LL=0:IFW>SATHENW=W-SA:LL=1:IFW>127THENER=1
3515 IFLL=1THENLL=0:GOTO3530
3520 IFW<SATHENW=SA-W-1:IFW<127THENW=255-W:W=WOR128:GOTO3530
3525 ER=1
3530 SA=SA-1:IFER=1THENSA=SA-1:GOTO3550
3535 A=W:POKESA,A:GOSUB400:PRINTQ$;TAB(20);AS$(D,0)" $"L$
3540 SA=SA+1:ER=0
```

Line 4000 This program checks your data statements. Although it will still be difficult to trace errors, stopping the program during the menu and typing 'GOTO 4000' will give you clues to where errors are, if there are any. If you own a book containing a list of 6502 instructions and their modes, look up the values of the incorrec command and find it in the last half of the data.
The reversed 'n' in line 4003 is obtained by pressing 'CTRL' and 'N' simultaneously.

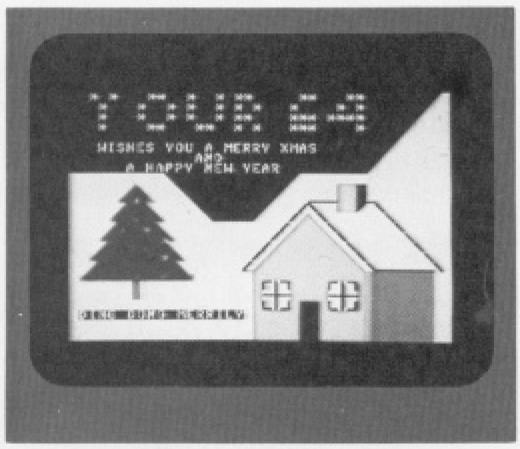
```
3550 RETURN
3600 PRINT"▓▓▓":CLR:LOAD:GOTO6
3610 INPUT"▓START ADDRESS (IN HEX)";SA$:IFLEN(SA$)><4THEN3610
3620 INPUT"END   ADDRESS          ";EA$:IFLEN(EA$)<>4THEN3620
3625 IFSA$="****"OREA$="****"THEN120
3630 A$=LEFT$(SA$,2):GOSUB350:IFERTHEN3600
3640 POKE254,Q
3645 A$=RIGHT$(SA$,2):GOSUB350:IFERTHEN3600
3647 POKE253,Q
3650 A$=LEFT$(EA$,2):GOSUB350:IFERTHEN3600
3655 POKE252,Q
3660 A$=RIGHT$(EA$,2):GOSUB350:IFERTHEN3600
3665 POKE251,Q
3670 PRINT"▓DO YOU NEED MEMORY ADDRESSES"
3675 PRINT"    (32768-32786) ($8000-$8012) ?▓"
3676 PRINT"IF SO PRESS RETURN."
3677 N=0:FORI=1TO1000:GETR$:IFR$=CHR$(13)THENN=1
3678 NEXTI:SA=32768:IFN=0THEN3681
3679 INPUT"SUGGESTED MEMORY AREA";SA$:GOSUB300:IFERTHEN3679
3680 SA=Q
3681 FORI=1TO18:POKESA-1+I,SV%(I):NEXT
3690 SYS (SA)
3695 GOTO120
4000 FORI=34TO56
4001 D=0:FORK=0TO255:IFAS$(I,0)=DI$(K,1)THEND=K
4002 NEXTK:PRINTAS$(I,0);
4003 IFVAL(AS$(I,VAL(DI$(D,2))))=DTHENPRINT"   CORRECT▓   ┘":GOTO4005
4004 PRINT"   WRONG     X"
4005 NEXT
```

KEYBOARD KAPERS

Being the Christmas issue, we've concentrated on short games listings rather than all-singing, all-dancing 20k programs. Trains *and* Snake *are old favourites, while* Xmas *is ... well, something to keep granny amused on Boxing Day ...*

XMAS

Xmas, by Clive Emberey, is the compulsory Christmas program. Those with violent objections to Christmas trees and carols are advised to skip this one ...!




```
100 REM LOWER TOP OF BASIC TO 12288
110 POKE 52,48:POKE 56,48:CLR
```

Line 110 Lowers the top of Basic to 12288

```
120 GOSUB 1780:REM SET UP SPRITES
```

Line 120 Sets up the sprites

```
130 DIM H%(60),L%(60),D%(60):REM NOTES
```

Line 130 Dimensions the notes for the carols

```
140 REM SET UP SPRITES ALL MULTICOLOUR
150 POKE 53281,1:POKE 53280,0:LIGHT=5324
8
160 POKE 2040,208:POKE 2041,209
170 POKE 2042,208:POKE 2043,209
180 POKE 2044,208:POKE 2045,209
190 POKE 2046,209:POKE 2047,209
200 POKE LIGHT+28,255
210 POKE LIGHT+37,2:POKE LIGHT+38,14
220 POKE LIGHT+39,7:POKE LIGHT+40,7
230 POKE LIGHT+29,255:POKE LIGHT+23,255
240 POKE LIGHT+21,255
250 POKE LIGHT,57:POKE LIGHT+1,120
260 POKE LIGHT+2,57:POKE LIGHT+3,120
270 POKE LIGHT+4,32:POKE LIGHT+5,167
280 POKE LIGHT+6,32:POKE LIGHT+7,167
290 POKE LIGHT+8,80:POKE LIGHT+9,167
300 POKE LIGHT+10,80:POKE LIGHT+11,167
310 POKE LIGHT+12,45:POKE LIGHT+13,144
320 POKE LIGHT+14,65:POKE LIGHT+15,144
```

Lines 150-320 Sets all sprites to multicolour

```
330 PRINT"J"
340 TREE=0:GOSUB 1000:REM DRAW TREE
```

Lines 330-340 Draws the Christmas tree

```
350 HOUSE=18:GOSUB 1150:REM DRAW HOUSE
360 GOSUB 1630
```

Lines 350-360 Draws the house

```
370 REM PLAY DING DONG
380 READ PRESENTS:GOSUB 1810
390 REM PLAY SILENT NIGHT - BADLY
400 PRINT"SQQQQQQQQQQQQQQQQQQQQQQQ DING
 DONG MERRILY"
410 GOSUB 1840:FORI=1 TO 1000:NEXT I
420 READ PRESENTS:GOSUB 1810
430 PRINT"SQQQQQQQQQQQQQQQQQQQQQQQ SILE
NT NIGHT        "
440 GOSUB 1840:RUN
```

Lines 380-440 Plays the carols

```
450 REM CHRISSIE LIGHT DATA
460 DATA 0, 16, 0, 0, 16, 0, 0, 0, 0, 0,
 0
470 DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
480 DATA 12, 0, 128, 12, 0, 128, 0, 0, 0
, 0
490 DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
500 DATA 0, 0, 0, 0, 128, 0, 1, 128, 0,
1
510 DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
520 DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
530 DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
540 DATA 0, 0, 0, 0, 0, 16, 0, 0, 16, 0
550 DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
560 DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 48
570 DATA 0, 0, 48, 0, 0, 0, 0, 0, 0, 0
580 DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
```

Lines 460-580 DATA for the Christmas tree lights

```
590 REM DING DONG MERRILY DATA
600 DATA 54
610 DATA 25 , 30 , 8 , 25 , 30 , 8 , 28
, 49 , 4
620 DATA 25 , 30 , 4 , 23 , 181 , 4 , 21
, 31 , 4
630 DATA 18 , 209 , 24 , 18 , 209 , 8 ,
21 , 31 , 8
640 DATA 25 , 30 , 8 , 25 , 30 , 8 , 23
, 181 , 8
650 DATA 25 , 30 , 16 , 25 , 30 , 16 , 3
7 , 162 , 12
660 DATA 33 , 135 , 4 , 31 , 165 , 4 , 3
3 , 135 , 4
670 DATA 37 , 162 , 4 , 31 , 165 , 4 , 3
3 , 135 , 12
680 DATA 31 , 165 , 4 , 28 , 49 , 4 , 31
, 165 , 4
690 DATA 33 , 135 , 4 , 28 , 49 , 4 , 31
, 165 , 12
700 DATA 28 , 49 , 4 , 25 , 30 , 4 , 28
, 49 , 4
710 DATA 31 , 165 , 4 , 25 , 30 , 4 , 28
, 49 , 12
720 DATA 25 , 30 , 4 , 23 , 181 , 4 , 25
, 30 , 4
730 DATA 28 , 49 , 4 , 23 , 181 , 4
740 DATA 25 , 30 , 12 , 23 , 181 , 4 , 2
1 , 31 , 4
750 DATA 23 , 181 , 4 , 25 , 30 , 4 , 21
, 31 , 4
760 DATA 23 , 181 , 12 , 21 , 31 , 4 , 1
8 , 209 , 8
770 DATA 18 , 209 , 8 , 21 , 31 , 8 , 25
, 30 , 8
780 DATA 25 , 30 , 8 , 23 , 181 , 8 , 25
, 30 , 16
790 DATA 25 , 30 , 16
```

Lines 600-790 DATA for Ding Dong Merrily

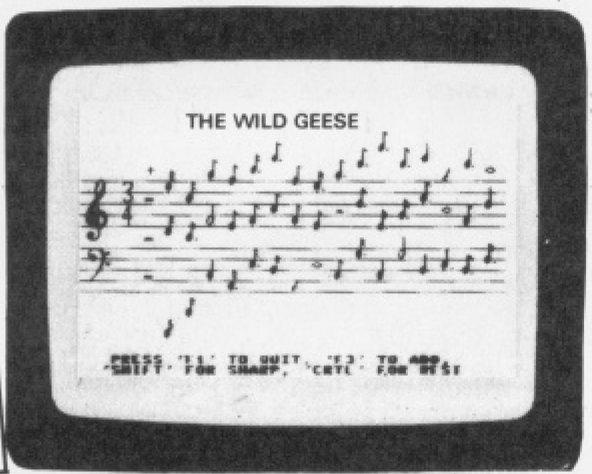
```
800 DATA 18,3 :REM TEMP,REPETITIONS
```

Line 800 DATA for tempo and number of repetitions

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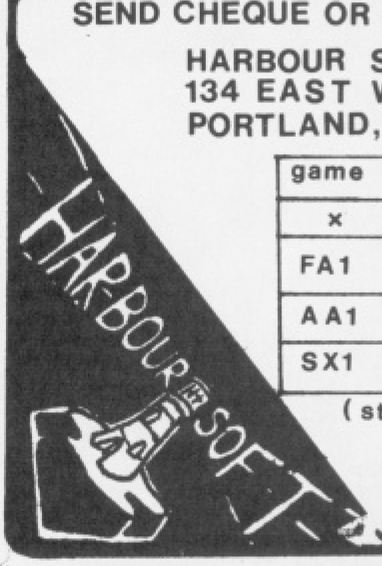
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```
810 REM SILENT NIGHT DATA
820 DATA 46
830 DATA 25 , 30 , 6 , 28 , 49 , 2 , 25
, 30 , 4
840 DATA 21 , 31 , 12 , 25 , 30 , 6 , 28
, 49 , 2
850 DATA 25 , 30 , 4 , 21 , 31 , 12 , 37
, 162 , 8
860 DATA 37 , 162 , 4 , 31 , 165 , 12 ,
33 , 135 , 8
870 DATA 33 , 135 , 4 , 25 , 30 , 12 , 2
8 , 49 , 8
880 DATA 28 , 49 , 4 , 33 , 135 , 6 , 31
, 165 , 2
890 DATA 28 , 49 , 4 , 25 , 30 , 6 , 28
, 49 , 2
900 DATA 25 , 30 , 4 , 21 , 31 , 12 , 28
, 49 , 8
910 DATA 28 , 49 , 4 , 33 , 135 , 6 , 31
, 165 , 2
920 DATA 28 , 49 , 4 , 25 , 30 , 6 , 28
, 49 , 2
930 DATA 25 , 30 , 4 , 21 , 31 , 12 , 37
, 162 , 8
940 DATA 37 , 162 , 4 , 44 , 193 , 4 , 3
7 , 162 , 4
950 DATA 31 , 165 , 4 , 33 , 135 , 12 ,
42 , 62 , 12
960 DATA 33 , 135 , 4 , 25 , 30 , 4 , 21
, 31 , 4
970 DATA 25 , 30 , 4 , 22 ,  96 , 4 , 18
, 209 , 4
980 DATA 16 , 195 , 24
990 DATA 40,3
```

Lines 820-990 DATA for Silent Night

```
1000 REM TREE
1010 PRINT"SQQQQQQQQQ"
1020 PRINTSPC(TREE)"         ◤◥"
1030 PRINTSPC(TREE)"        ◤  ◥"
1040 PRINTSPC(TREE)"        ◤  ◥"
1050 PRINTSPC(TREE)"       ◤    ◥"
1060 PRINTSPC(TREE)"       ◤    ◥"
1070 PRINTSPC(TREE)"      ◤      ◥"
1080 PRINTSPC(TREE)"      ◤      ◥"
1090 PRINTSPC(TREE)"     ◤        ◥"
1100 PRINTSPC(TREE)"     ◤        ◥"
1110 PRINTSPC(TREE)"    ◤          ◥"
1120 PRINTSPC(TREE)"    ▌     ▌"
1130 PRINTSPC(TREE)"         ▌▐"
1140 RETURN
```

Lines 1010-1140 Draws the tree

```
1150 REM HOUSE
1160 PRINT"SQQQQQQQQQ"
1170 PRINTSPC(HOUSE+7)"■    ■  ■ ■"
1180 PRINTSPC(HOUSE+7)"■____■  ■ ■_"
1190 PRINTSPC(HOUSE)"       ■/";
1200 PRINT"■\  ■  ■◤ \"
1210 PRINTSPC(HOUSE)"      ■/■◤◥■";
1220 PRINT"■\       \"
1230 PRINTSPC(HOUSE)"     ■/■◤   ◥■";
1240 PRINT"■\       \"
1250 PRINTSPC(HOUSE)"    ■/■◤     ◥■";
1260 PRINT"■\       \"
1270 PRINTSPC(HOUSE)"   ■/■◤       ◥■";
1280 PRINT"■\       \"
1290 PRINTSPC(HOUSE)"  ■/■◤         ◥■";
1300 PRINT"■\       \"
1310 PRINTSPC(HOUSE)"■/■◤           ◥■";
1320 PRINT"■\________\"
1330 PRINTSPC(HOUSE)"■◥■              ";
1340 PRINT"■               "
1350 PRINTSPC(HOUSE)" ■■ ■┌|┐■     ■┌|
┐■ ";
1360 PRINT"■               "
1370 PRINTSPC(HOUSE)" ■■ ■-+-■     ■-+
-■ ";
1380 PRINT"■               "
1390 PRINTSPC(HOUSE)" ■■ ■└|┘■ ■   ■ ■
└|┘■ ";
1400 PRINT"■               "
1410 PRINTSPC(HOUSE)" ■■      ■  ■      ";
1420 PRINT"■               "
1430 PRINTSPC(HOUSE)" ■■      ■  ■      ";
1440 PRINT"■               "
1450 PRINTSPC(HOUSE)" ■■      ■  ■      ";
1460 PRINT"■        ■"
1470 RETURN
```

Lines 1160-1470 Draws the house

```
1480 REM STARS
1490 PRINT"■■
           ◤"
1500 PRINT"■
          ◤"
1510 PRINT"■
         ◤"
1520 PRINT"■
        ◤"
1530 PRINT"■
       ◤"
1540 PRINT"■
      ◤"
1550 PRINT"■
     ◤"
1560 PRINT"■
    ◤"
1570 PRINTSPC(10)"■◥■             ◤"
1580 PRINTSPC(11)"■◥■           ◤"
1590 PRINTSPC(12)"■◥■         ◤"
1600 PRINTSPC(13)"■◥■       ◤"
1610 PRINTSPC(14)"■◥■     ◤"
1620 RETURN
```

Lines 1490-1620 Draws the stars

```
1630 REM STARS+MESSAGE
1640 PRINT"■■  * *   **  *  * **     **
 **      ◤"
1650 PRINT "■   *   *  * *  * * *   *
 * *    ◤"
1660 PRINT"■   *   *  * *  * **    ***
****   ◤"
1670 PRINT"■   *    **   **  * *   ***
  *    ◤"
1680 PRINT"■
         ◤"
1690 PRINT"■    WISHES YOU A MERRY XMAS
        ◤"
1700 PRINT"■             AND
       ◤"
1710 PRINT"■        A HAPPY NEW YEAR
      ◤"
1720 PRINTSPC(10)"■◥■             ◤"
1730 PRINTSPC(11)"■◥■           ◤"
1740 PRINTSPC(12)"■◥■         ◤"
1750 PRINTSPC(13)"■◥■       ◤"
1760 PRINTSPC(14)"■◥■     ◤"
1770 RETURN
```

Lines 1640-1770 Merry Christmas from all at Y64!

```
1780 REM LIGHT SPRITE DATA
1790 FOR I=208*64 TO 208*64+130
1800 READ A:POKE I,A:NEXT I:RETURN
```

Lines 1790-1800 Reads in the sprite DATA for lights



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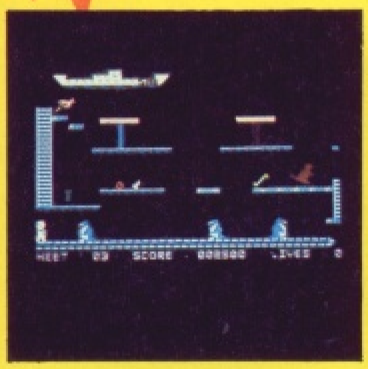
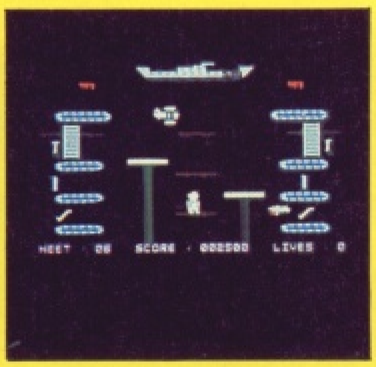
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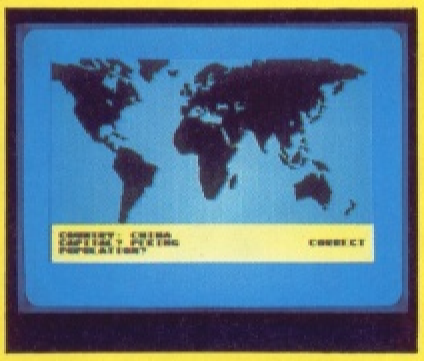


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```
1810 REM READ CAROL DATA
1820 FOR I=1 TO PRESENTS:READ H%(I),L%(I
),D%(I)
1830 NEXT I:READ CAROL,VERSES:RETURN
```

Lines 1820-1830 Reads in the DATA for the carols

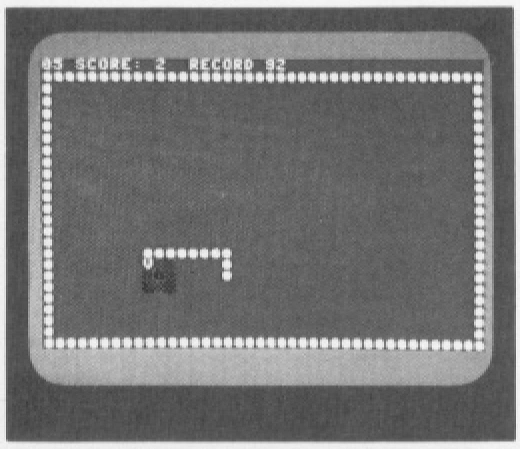
```
1840 REM PLAY CAROL
1850 POKE 54277,64:POKE 54278,64:REM ATT
&SUS
1860 NOEL=33:CHOIR=54296:JESUS=54273
1870 MARY=54272:JOSEPH=54276:POKE CHOIR,
15
1880 FOR K=1 TO VERSES
1890 FOR I=1 TO PRESENTS
1900 POKE MARY,L%(I):POKE JESUS,H%(I)
1910 POKE JOSEPH,NOEL:FOR J=1 TO D%(I)*C
AROL:NEXTJ
1920 POKE LIGHT+21,RND(0)*256
1930 NEXT I
1940 IF F=0 THEN F=1:GOSUB 1480:GOTO 196
0
1950 IF F=1 THEN F=0:GOSUB 1630:GOTO 196
0
1960 NEXT K:POKE CHOIR,0
1970 RETURN
```

Lines 1850-1990 Plays a carol

SNAKE

This one's been around almost as long as the PET, but it's still a difficult and addictive game for all that! This version is by Clive Emberey.

The idea is to guide the snake around the screen eating the numbers that appear for a short time. As you eat a number, the length of the snake increases by a corresponding number of units. The aim is to become as long as possible without colliding with either the walls or your own tail! The time limit is 60 seconds. Instructions appear on the screen.




```
100 REM SNAKE
110 REM NOT AN ORIGINAL
120 PRINT"▯▮"TAB(15)"▮________■"
130 PRINTTAB(15)"▮ SNAKE ■"
140 PRINTTAB(15)"▮‾‾‾‾‾‾‾‾■"
150 PRINT:PRINT"GUIDE YOUR SNAKE AROUND
THE FIELD BY THE
160 PRINT"USE OF THESE KEYS:-"
170 PRINT
180 PRINTTAB(15)"    UP
190 PRINTTAB(15)"    ┌─┐
200 PRINTTAB(15)"    │;│
210 PRINTTAB(15)"  ──┴─┴──
220 PRINTTAB(15)"   │   │
230 PRINTTAB(10)"LEFT │Z│   │X│ RIGHT
240 PRINTTAB(15)"  ──┬─┬──
250 PRINTTAB(15)"    │ │
260 PRINTTAB(15)"    │/│
270 PRINTTAB(15)"    └─┘
280 PRINTTAB(15)"   DOWN
290 PRINT:PRINT"TRY TO HIT THE BOXES FOR
 POINTS.
300 PRINT:PRINTTAB(7)"▮PRESS ANY KEY TO
CONTINUE■"
310 GETA$:IFA$=""THEN310
320 PRINT"▯▮THE BOXES HAVE DIFFERENT VAL
UES & STAY
330 PRINT:PRINT"ON THE SCREEN FOR DIFFER
ENT LENGTHS OF
340 PRINT:PRINT"TIME. SHOULD YOU HIT THE
 BOUNDARY OR
350 PRINT:PRINT"STEER INTO YOUR OWN TAIL
, THE GAME
360 PRINT:PRINT"STOPS.
370 PRINT:PRINT"YOU HAVE 60 SECONDS OF P
LAY.
380 PRINT:PRINTTAB(7)"▮PRESS ANY KEY TO
START■"
390 GETA$:IFA$=""THEN390
```

Lines 100-390 Instructions for program.

```
400 DIMP(80),D(3)
410 RZ=92
420 D(0)=22:D(1)=60:D(2)=62:D(3)=30
430 T9=1024:T6=3599:POKE53272,21
440 POKE54278,128
450 M1=54296:M2=54273:M3=54272
460 POKE54276,129
470 PRINT"▯   SCORE: 0  RECORD";RZ
480 FORJ=1064TO1103:POKEJ,81:POKEJ+920,8
1:POKEJ+M3,1:POKEJ+920+M3,1:NEXTJ
490 FORJ=1104TO1984STEP40:POKEJ,81:POKEJ
+39,81:POKEJ+M3,1:POKEJ+39+M3,1:NEXT
500 V=20:H=35:V1=0:H1=-1:P2=10:D1=1
```

Lines 400-500 Sets up defaults and fixed variables and produces display.

```
510 TI$="000000"
```

Line 510 Zero time.

```
520 PRINT"▮";RIGHT$(TI$,2):IFTI>T6THENZZ
=1:GOTO850
530 GETZ$:IFZ$=""GOTO600
```

Line 530 Scans for control key.

```
540 IFZ$=";"THENZ=3:GOTO590
550 IFZ$="X"THENZ=2:GOTO590
560 IFZ$="Z"THENZ=1:GOTO590
570 IFZ$="/"THENZ=0:GOTO590
```

Lines 540-570 Action control key.

```
580 GOTO 600
590 D1=Z:D=Z-1.5:V1=INT(ABS(D))*SGN(D):H
1=SGN(D)-V1
```

Line 590 Move selected.

```
600 V=V-V1:H=H+H1
610 P=T9+V*40+H
620 P9=PEEK(P):POKEM1,15:POKEM3,29*D1+80
:POKEM2,15
630 R6=R7:R7=R7+1:IFR7>P2THENR7=0
640 P1=P(R7):P(R7)=P:POKEM1,0:IFP1<>0THE
NPOKEP1,32
650 POKEP,D(D1):POKEP+M3,1:P1=P(R6):IFP1
<>0THENPOKEP1,81
```

Lines 600-650 Performs move.

```
660 IFP9<>32GOTO770
```

Line 660 Checks for possible score.

```
670 IFRND(1)>.05GOTO520
680 FORV3=V2-1TOV2+1:P3=V3*40+T9:FORH3=H
2-1TOH2+1:IFPEEK(P3+H3)<>102GOTO700
690 POKEP3+H3,32
700 NEXTH3,V3:T=0:POKEP8,32
```

YOUR 64 DEC-JAN AD INDEX

```
710 V2=INT(RND(1)*20)+3:H2=INT(RND(1)*36
)+2
720 FORV3=V2-1TOV2+1:P3=V3*40+T9:FORH3=H
2-1TOH2+1:IFPEEK(P3+H3)<>32GOTO710
730 NEXTH3,V3:FORV3=V2-1TOV2+1:P3=V3*40+
T9:FORH3=H2-1TOH2+1
740 POKEM1,15:POKEM2,15:POKEM3,30
750 POKEP3+H3,102:POKEP3+H3+M3,0:POKEM1,
0
760 NEXTH3,V3:T=9*RND(1):P8=V2*40+H2+T9:
POKEP8,49+T:POKEP8+M3,1:GOTO520
```

Lines 680-760 Continue move.

```
770 IFP9<>102GOTO830
```

Line 770 Hit edge of board?

```
780 T$=TI$
790 T=T-1:S=S+1:POKEP8,T+49:POKEP8+M3,T+
1:POKEM1,15:POKEM2,15
800 PRINT"[graphics]";S
810 FORJ=100TO30STEP-1:POKEM3,J:NEXT:POK
EM1,0:IFT>=0GOTO790
820 P2=P2+1:TI$=T$:GOTO680
```

Lines 780-820 No, so must have scored — updates score and checks if any time remains.

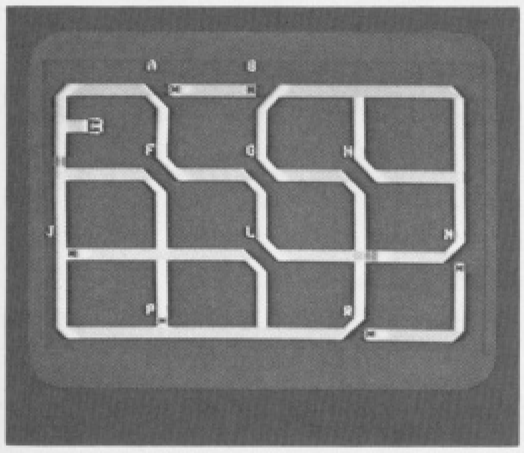
```
830 POKEM1,15:POKEM2,15:POKEM3,200:FORJ=
1TO1000:NEXT
840 POKEM1,0:POKE54278,0:POKE54276,0
850 IFS<=RZTHEN910
860 IFZZ<>1THEN910
```

Lines 830-860 Checks condition at which game ends.

```
870 PRINT"[graphics] [graphics]YOU HAVE BROKEN THE REC
ORD SCORE ...[graphics]"
```

Line 870 Repeat score and replay?

```
880 PRINT"[graphics] [graphics]HIT THE 'STOP' KEY AND EDIT
 LINE 475"
890 PRINT"[graphics]       THEN TYPE 'SAVE SNAKE
  '  [graphics]"
900 POKET9+5*40+24,162:POKET9+5*40+31,16
2
910 PRINT"[graphics]"TAB(23)"[graphics]ANOTHER GAME?[graphics]    [graphics]
[graphics]";
920 GETZ$:IFZ$=""GOTO920
930 IFZ$="Y"THENCLR:GOTO400
940 IFZ$<>"N"GOTO920
950 PRINT"[graphics]";
960 END
```



TRAINS

I first played this on a PET, then about a year later on a Sharp MZ-80K and now, thanks to Clive Emberey, on the 64 — and I still can't do it!

The object of the exercise is to operate the points of a railway network. You have to keep an increasing number of trains on the move without any of them derailing or colliding. As an added problem, some of the points will — of course — fail and close themselves down for repairs. (Regular commuters will know that "points failure" seems to account for just about every problem experienced by British Rail).

Trains is a game calling for both strategy and fast reactions. Instructions are given in the program. Happy commuting!

```
100 DIMA$(12),P%(18),T%(8,3)
110 GOSUB 1160
```

Line 110 Instructions and selects level.

```
120 F=0:M=1:U=1:X=160:Y=163:Z=1024:ZZ=54
272:QZ=1
```

Line 120 Sets up default values.

```
130 D$="[graphics]"
```

Line 130 D$ for moving down screen.

```
140 A$(0)=" [graphics] "
150 A$(1)="[graphics] "
160 A$(2)="[graphics] "
170 A$(3)="[graphics]"
180 A$(4)="[graphics]"
190 A$(5)="":A$(7)=""
200 A$(6)=" [graphics] "
210 A$(8)=" [graphics]"
220 A$(9)=" [graphics]"
230 A$(10)="[graphics]"
240 A$(11)="[graphics]"
250 A$(12)="[graphics]"
```

Lines 140-250 Array A$ for initial set up of tracks.

```
260 Z$="[graphics]":FOR I=1 TO 39:Z$=Z$+" "
```

Lines 260-270 Z$ to clear a row.

```
270 NEXT I:Z$=Z$+"[graphics]"
280 IF V<.2 THEN A$(2)="[graphics]
"
290 IF V<.4 THEN A$(8)=" [graphics]    "
```

Lines 280-290 On V vary initial set up.

```
300 FOR I=1 TO 8:T%(I,1)=203:T%(I,2)=-1
310 T%(I,3)=X:NEXT I
320 PRINT"[graphics]":FOR I=1 TO 3
330 GOSUB 960:FOR J=1 TO 6
340 GOSUB 1010:PRINT"[graphics] ":NEXT J,I
350 GOSUB 960
360 POKE ZZ+Z+81,QZ:POKE Z+81,233:POKE Z
Z+Z+117,QZ:POKE Z+117,223
370 POKE Z+ZZ+921,QZ:POKE Z+921,95:POKE
ZZ+Z+957,QZ:POKE Z+957,105
380 FOR I=0 TO 10:READ J:POKE Z+ZZ+J,QZ:
POKE Z+J,96:NEXT I
```

Lines 320-380 Draws track.

```
390 FOR I=65 TO 82:K$=CHR$(I)
400 GOSUB 1030:IF P%(A)=5 THEN NEXT
410 IF RND(1)<.5 THEN P%(A)=12-P%(A)
420 PRINT"[graphics]";K$;"[graphics]";A$(P%(A)):NEXT I
430 PRINT"[graphics]"
```

Lines 390-430 Displays points A-R.

```
440 B=TI
450 T=TI
```

Lines 440-450 Starts timer.

```
460 GETK$:IF K$<"A" OR K$>"R" THEN 490
470 GOSUB 1030:P%(A)=12-P%(A)
480 PRINT A$(P%(A))
490 D=T%(U,2):P=Z+T%(U,1):K=T%(U,3)
500 IF K=X THEN 530
510 IF K=Y OR K=170 OR K=32 THEN 800
520 D=40/D:IF K AND 32 THEN D=-D
530 T%(U,2)=D:POKE P+ZZ,QZ:POKE P,T%(U,3
)
540 IF PEEK(P+D)=96 THEN T%(U,2)=SGN((U
```

```
AND 1)-.5)*40/D:GOTO 490
550 P=P+D:T%(U,3)=PEEK(P):POKE P+ZZ,QZ:P
OKE P,Y
560 T%(U,1)=T%(U,1)+D
570 FOR I=1 TO 180/M-7*M:NEXT I
580 U=U+1:IF U>M THEN U=1
590 IF TI-T<800*(1+RND(1)) THEN 460
600 IF TI-B>14400 THEN 910
610 IF F THEN 740
620 IF RND(1)<V THEN GOSUB 690
630 M=M-(M<N):GOTO 450
```

Lines 460-630 CONTROL MODULE OF THE GAME: Allows switching of points; checks for collision of any of the trains currently in action with a closed down or switched point: randomly closes down points.

```
640 FOR I=0 TO 12:PRINT"ℷ";TAB(I);K$
```

Line 640 Prints points.

```
650 FOR J=1 TO 110:NEXT J,I
660 PRINT:RETURN
670 GET K$:IF K$<>" " THEN 670
```

Line 670 Wait.

```
680 PRINT"ℷ";:RETURN
690 Q=6-5*(RND(1)<.5)+INT(3*RND(1))
```

Line 690 Warns points about to close.

```
700 K$=CHR$(Q+64):F=1
710 PRINT Z$;" POINTS AT ";K$;" CLOSING
DOWN SOON▪▪"
720 PRINT"▪▪▪▪▪▪▪▪▪A▪▪▪▪▪▪▪▪▪▪B▪▪▪▪▪▪▪▪▪▪C"
730 GOSUB 1030:PRINT"ℷ";K$:RETURN
740 PRINT Z$;:IF F=2 THEN 770
```

Line 740 Clears closed points.

```
750 A=Q:GOSUB 1040:PRINT A$(6)
760 P%(A)=6:F=2:GOTO 450
770 F=0:A=Q:P%(A)=0
780 PRINT"POINTS NOW CLEAR"
790 GOSUB 1040:PRINT A$(0):GOTO 450
800 B=INT((TI-B)/60)
```

Line 800 Crashed — report score.

```
810 PRINT Z$;"CRAAAASH!!!!"
820 S=37:FOR I=0 TO 9:RESTORE:FOR J=1 TO
 9
830 READ C:POKE P+ZZ+C,QZ:POKE P+C,S+I:N
EXT J,I
840 FOR I= 1 TO 1000:NEXT I
850 PRINT"ℷYOU SURVIVED FOR";B;"SECONDS"
860 PRINT"▪▪YOUR SCORE WAS";INT(100*(B/2
40)↑(1-V));"%"
870 PRINT"▪▪PLAY AGAIN (Y/N)?"
```

Line 870 Play again?

```
880 GET K$:IF K$="N" THEN END
890 IF K$<>"Y" THEN 880
900 RESTORE:GOSUB 1370:GOTO 120
910 FOR I=0 TO 2000:NEXT I
```

Line 910 Congratulations — completed course.

```
920 PRINT"ℷYOU LASTED OVER FOUR MINUTES!
!!▪▪"
930 PRINT"DO BRITISH RAIL AND JIMMMY SAV
ILLE KNOW"
940 PRINT"▪▪ABOUT YOU ?"
950 GOTO870
960 PRINT"▪";:FOR J= 1 TO 37
```

Line 960 Draw.

```
970 PRINT"▪ ";:NEXT:PRINT:RETURN
980 S=36:FORI=0 TO 9:RESTORE:FOR J=1 TO
9
990 READ C:POKEZZ+P+C,QZ:POKEP+C,S:NEXT
J
1000 S=79-S:NEXT I
1010 PRINT"▪";:FOR K=1 TO 4
1020 PRINT"▪ ■          ";:NEXT K:RETURN
1030 A=ASC(K$)-64
```

Line 1030 Switches points on K$ in line 460.

```
1040 R=INT(A/5):C=9*(A-5*R)
1050 PRINTLEFT$(D$,2+7*R);SPC(C);
1060 RETURN
1070 DATA -41,-40,-39,1,41,40,39,-1,0
1080 DATA 1,1,5,5,5,0,0,0,5
1090 DATA 2,5,0,5,3,5,4,5,4
1100 DATA 1,1,1,5,5,0,5,0,3
1110 DATA 2,0,0,5,5,5,5,4,4
1120 DATA 1,1,1,5,2,0,0,0,3
1130 DATA 2,0,0,0,3,5,4,4,4,0
1140 DATA 50,59,68,200,360,398
1150 DATA 640,678,970,979,988
1160 POKE 53280,0:POKE53281,0
```

Line 1160 Instructions and set level.

```
1170 PRINT"ℷ▪▪▪▪▪█"
1180 K$="     TRAINS":GOSUB 640
1190 K$="     ───────":GOSUB 640:PRINT
1200 K$=" FOR THE 64 BY YOUR 64":GOSUB 6
40
1210 PRINT"▪▪▪▪▪ALWAYS PRESS THE SPACE B
AR WHENEVER YOU"
1220 PRINT"▪ ARE READY TO PROCEED TO THE
 NEXT PAGE"
1230 PRINT"▪ NEVER THE CARRIAGE RETURN"
1240 GOSUB670
1250 PRINT"TRY TO CONTROL THE TRAINS (#)
 AS THEY GO"
1260 PRINT"ROUND THE SYSTEM.   EACH OF T
HE POINTS▪"
1270 PRINT"IS LABELLED WITH A LETTER A-R
.  YOU CAN▪"
1280 PRINT"SWITCH THE POINTS BY PRESSING
 THE KEY▪"
1290 PRINT"HAVING THE SAME LETTER.KEEP T
HEM MOVING▪"
1300 PRINT"AS LONG AS YOU CAN!!▪▪"
1310 PRINT"IN THE EVENT OF ANY ACCIDENTS
,THE GAME▪"
1320 PRINT"STOPS AND YOUR SCORE IS GIVEN
▪▪"
1330 PRINT"AT IRREGULAR INTERVALS SOME P
OINTS MAY▪"
1340 PRINT"CLOSE FOR A WHILE FOR REPAIRS
.KEEP AN▪"
1350 PRINT"EYE ON THE TOP OF THE SCREEN
FOR DETAILS";
1360 GOSUB 670
1370 PRINT"CHOOSE DIFFICULTY 1,2 OR 3▪▪"
1380 PRINT"1=EASY...3=HARD-YOUR CHOICE";
1390 INPUT"▪▪I.▪▪▪▪";K$:V=ASC(K$)-48
1400 IF V<1 ORV>3 THEN 1380
1410 FOR I= 1 TO 9+18*(V-1):READ S:NEXT
I
1420 FOR I=1 TO 18:READ P%(I):NEXT I
1430 FOR I=0 TO 18*(3-V):READ S:NEXT I
1440 N=2+2*V:V=V/7
1450 POKE53281,6:POKE53280,14
1460 RETURN
```

THE BIG THREE

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TALKIN' 64

Not content with opening Britain's first home computer shop six years ago, Gordon Ashbee has just opened Britain's first specialist robot shop — The Robot Workshop. Ed Rowetitt *went to meet the man and his robots.*

The Robot Workshop is just a stone's throw from Earl's Court in south London. From the outside it looks like a fairly typical hardware shop, but once inside it lives up to its name. The benches at the front of the shop are filled with an assorted collection of machines from conventional robot arms through turtle-like, battery-powered line-tracers to the less robotic looking measuring devices and plotters, with a workbench at the back strewn with bits and pieces of half-built robots.

Gordon Ashbee has the air of a conventional, late middle-aged businessman. Which, in his role as managing director of Entryphone Ltd, he is. In the workshop, though, he's clearly an enthusiast in his element.

What does Ashbee think is the appeal of robots? Even people who have no interest in computing or electronics seem to be fascinated by them. "I think anything that does something without direct human control is fascinating to anybody whether mechanically minded or not. I'm told in America they have robots walking around in bars serving people drinks.

"I think the main thing with robots is that they're becoming accessible, like computers have. Until 1976, you could only afford a computer if you had something like £35,000 to spend. Now what's the cheapest computer? About £35? At the moment, a proper industrial robot will cost you somewhere around £30,000. I'm not suggesting that this sort of robot will come down to £35, but I don't see why it shouldn't be divided by a very big number. I'd say it should very soon be possible to buy a working, industrial robot for under £500."

How does Ashbee define a 'robot'? Some of the devices on display aren't what most people would think of as robots, the plotter for example. "It's anything that adds physical movement to a computer — gives it muscle."

We can all see the use of an industrial robot arm, spraying cars and so on, but how can small robots be useful?

"I recently had a customer who wanted a device to close his curtains using an infra-red control unit. He wanted to know if that sort of thing was a robot. And of course he's right — it is. Closing the curtains, opening garage doors ... simple things like that make a good introduction to robotics, particularly if someone can build it themselves."

"The basic principle of the workshop is like The Computer Workshop. People can come in here and discuss their needs. People who come in and ask questions often don't realise that they are giving me information, because I'm going through the same learning process they are. And as soon as we get half a dozen people in at the same time, then everyone will be swapping notes."

Ashbee sees most of his customers building their own robots. I asked Ashbee where a hobbyist with a 64 and an interest in, but no knowledge of, robotics would begin. "Well, the first priority is reading. There's no substitute for reading about the subject before you start. You've got to get some basic terminology. You picked up a book (The Usborne Guide to Robotics) which would certainly take you through the first few hours of learning.

"Next you've got to decide what you actually want to do. You can either buy a ready-built device like the Beastie (a small robot arm): we're testing the 64 software for this at the moment. Or you can build from a kit, and we've got quite a selection of these available for the 64 — the Armdroid, the Ogre 1, the Micrograsp, Helot 2 and so on. All of these, incidentally, are also available ready-built for those who don't want to have to get out a soldering iron and screwdriver."



TONY SLEEP

Gordon Ashbee: actively looking for enthusiasts — and robots — to join his robot shop.

What's the sort of price difference between a kit and a ready-built robot? "With the simple ones, the difference is a few pounds. For something like the Armdroid 1, where the mechanics are supplied in kit form but the electronics are ready-built, the assembly charge is £50. For Micrograsp, where both mechanics and electronics are supplied as kits, the charge would be £100."

"I see numerically-controlled machines as the next step of the low-cost robot. The cheapest machine that I've come across capable of x/y control (getting the robot to move to a specific point on a plane by giving it x/y coordinate) costs about £12,000 — way out of reach of the hobbyist. I'm convinced that there must be people out there working on this problem, it's just a question of finding them. It doesn't matter if they've only made one, it's not quantity that matters, it's the ideas."

It's clear that Ashbee's prime aim is to create the space for people to come in, ask questions, share ideas and simply chat to each other about robots. "The workshop wasn't opened primarily as a profit-making operation. Obviously in order to be able to afford to keep it open and to do things it's got to make some money, but it's primarily about getting people in here. If anyone has made any kind of robot, whether or not they intend to build more of them, we'll put it in our showroom for free. Of course, if they want to make a commercial venture of it then, yes, we'd need some of the revenue in order to support the showroom, but if someone has made a one-off item, we'll happily show it."

Ashbee is actively seeking enthusiasts to help the workshop to grow. "I'm looking for the same type of lads we had staffing The Computer Workshop — people who have proved their enthusiasm. They can play at their hobby using the facilities the workshop has to offer, while at the same time benefitting the shop. The benefit is mutual."

Does Ashbee think robots will take off in the same way micros did? "No, I don't think so. But as to how many people will become involved, I don't know." Time will tell.

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